BRITISH ANTS

THEIR LIFE-HISTORY AND CLASSIFICATION

BY

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DEDICATED

AS A TOKEN OF ESTEEM

AND FRIENDSHIP

TO

WILLIAM MORTON WHEELER

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HARVARD UNIVERSITY, U.S.A.

PREFACE TO SECOND EDITION

When the first edition of this book was written I did not anticipate that in ten years' time a second edition would be required.

Realizing, however, that the copies were nearly exhausted I decided to accept Messrs. Routledge's offer to prepare a second edition bringing the work up to date, and also to write a new book devoted exclusively to the British Myrmecophilous fauna.

The former is now complete; the latter I hope to accomplish in the not distant future.

The study of ants has made considerable progress during the last ten years, and many important memoirs and books have been published—some of them to be briefly referred to below.

The increase in our knowledge of the distribution of the British *Formicidae* has been disappointing. Entomologists often do not appear to realize that for the purposes of a local list the commonest species are quite as necessary as the rarest. If the reader will kindly note from the information supplied in this book, the counties and vice-counties from which our commonest ants have never been recorded, and as opportunity offers will make a point of searching and of making his observations available, our knowledge of the distribution of British ants would soon be greatly increased. In the meantime I desire to thank Messrs. Britten, Butterfield, Hallett, Harwood, Hodson, Joy, Keys, C. Nicholson, Perkins, Phillips, Saunt, Stelfox, S. O. Taylor, and Waterston for kindly sending me ants to determine, and information concerning their occurrence in Britain.

Since the first edition of "British Ants" was published two new species have been discovered—*Myrmica schencki* Emery, by Mr. H. M. Hallett, and *Acanthomyops* (*Donisthorpea*) *brunneus* Latr., by Dr. N. H. Joy; also two new varieties are added—*Ponera punctatissima* var. *exacta* Sants., due to Dr. F. Santschi; and *Acanthomyops* (*Chthonolasius*), *umbratus* Nyl. var. *affino-umbratus* var. nov., by myself.

Among recent works which the student of Myrmecology will find

essential I place first, Chapters IV and V in W. M. Wheeler's "Social Life among the Insects" (1923). It is truly remarkable that the author should have been able to compress into this limited space such a store of information on nearly every subject connected with ants. Also his great work on "The Ants of the Belgian Congo" (1921–22), consisting of over 1000 pages and containing a key to all the genera of the ants of the world, should be consulted by all myrmecologists. The same author's "Ants of the Baltic Amber" (1914) is also a most useful and instructive work; and to those who are interested in the geological history of ants, attention may be directed to papers by Prof. Cockerell and myself on the British fossil ants, of which the titles will be found in the Bibliography at the end of this volume.

Emery, whose death on May 11th, 1925, leaves a void which can never be filled in the ranks of myrmecologists, had, fortunately for science, completed his great work in the "Genera Insectorum," 1901–25. Among his recent papers must be mentioned also a valuable memoir on the ants of Italy published in 1916. During his life he wrote some 295 publications on ants; not only was he a myrmecologist of the highest eminence, but also a just and generous man, who always gave full credit to others for their work.

Forel in 1915 republished the taxonomic part of his "Fourmis de la Suisse," bringing the synonymy up to date; and in 1923 he completed the five volumes of "Le Monde Social des Fourmis" of which an English translation will shortly appear. This, although in many ways a fine work, is somewhat disappointing in that it is not up to date, and that the opportunity has been made for airing the author's socialistic views. I should wish in particular to protest against the ants being employed as a supposed weapon in political controversy. In my opinion an entomological work is not the appropriate means for the introduction of political theories of any kind, still less for their glaring advertisement. Let those, however, who are so ready to set forth the social life of ants as a lesson to human beings, and an argument favouring a socialistic community, reflect on the following facts:—To all intents and purposes the working classes of ants are sterile! They have no trade union rules; each worker does as much work as she can from early morn to dewy eve, and often during the hours of the night as well. All are willing to sacrifice their lives at a moment's notice for the good of the state, and are ever industrious and contented.

leveloped heads in order to contain the powerful muscles of the aws with which they crush the hard seeds required for food; but when these workers are no longer needed by the colony, the other ants cut off their heads and throw them on the refuse heap. This is a very drastic, but effective, method of getting rid of a uperfluous working class.

Wasmann, whose interesting papers on ants and myrmecophiles number up to the present date some 250, published in 1925 a valuable work on ant mimicry, which is indispensable for those nterested in that subject. Schmitz, in 1916, wrote an interesting ccount of the Ants and Myrmecophiles of Holland; and Bondroit, n 1918, a book on the Ants of France and Belgium. The value of he latter is lessened, however, by the unnecessary multiplication f species, and the creation of many on the poorest of characters.

The attention of those interested in the Myrmecology of other ontinents is directed to the following publications—Arnold's ompletion of his monograph on the ants of South Africa, 1915–25; he papers on Australian ants, by Clark, Crawley, and Wheeler; on ants of Africa, South America, etc., by Santschi; and on ants and myrmecophiles in the Argentine, etc., by Bruch.

At the end of the novel "The Ants of Timothy Thümmel," by A. Ferenczy (1924), will be found some sixty pages of notes on the social life of ants, compiled with the assistance of Miss Cheesman and myself.

Finally, mention may be made of the chapter written by me in "The Life-Work of Lord Avebury (Sir John Lubbock)," 1924, edited by his daughter, The Hon. Mrs. Adrian Grant Duff.

I wish to express my best thanks to Mr. C. K. Ogden to whose good offices the publication of this edition is due; to Miss F. J. Kirk for compiling the Bibliography and the Index, and for help in other ways; to Mr. Engel Terzi for translations from the Italian; and to Professor E. B. Poulton for kind help and encouragement with the revision, etc.

HORACE DONISTHORPE.

June 30th, 1926.

CONTENTS

	PAGE
EFACE	vii
TRODUCTORY	3
TERNAL STRUCTURE	3
THE HEAD	3
THE THORAX	7
THE WINGS	9
THE ABDOMEN	9
THE GENITALIA	13
TERNAL STRUCTURE	17
THE GLANDS	19
GLANDS IN THE HEAD	19
THORACIC GLANDS	19
ABDOMINAL GLANDS	20
REPRODUCTIVE ORGANS	22
THE CIRCULATORY SYSTEM	25
THE RESPIRATORY SYSTEM	25
THE MUSCULAR SYSTEM	25
THE NERVOUS SYSTEM	26
FE HISTORY	26
PROPAGATION	26
COLONY FOUNDING	27
METAMORPHOSIS	29
PARTHENOGENESIS	30
LARVAE	30
PUPAE	33
POLYMORPHISM	34
YCHOLOGY	44
HOW ANTS KNOW EACH OTHER	48

CONTENTS

	PAGE
How Ants Communicate with Each Other	48
How Ants Find their Way	49
Geographical Distribution	52
Geological Record	53
Collecting	55
Mounting and Preserving	57
Observation-Nests	58
Indigenous Genera and Species	66
Ponerinae	67
Ponera	67
Myrmicinae	77
Myrmecina	79
Formicoxenus	88
Anergates	95
Monomorium	102
Solenopsis	109
Myrmica	115
Stenamma	152
Leptothorax	161
Tetramorium	189
Dolichoderinae	199
Tapinoma	199
Formicinae	205
Acanthomyops	206
Formica	281
Cosmopolitan and Introduced Species	384
Ponerinae	385
Myrmicinae	387
Dolichoderinae	394
Formicinae	396
Bibliography	407
Systematic Index: Ants and Myrmecophiles	429

LIST OF ILLUSTRATIONS

PLATES SEPARATELY PRINTED

PLATE		FACING PAGE
I.	Eggs, larvae, and pupae of *Ponera coarctata*, *Myrmecina graminicola*, *Solenopsis fugax*, and *Myrmica ruginodis*	30
II.	Eggs, larvae, and pupae of *Anergates atratulus*, *Monomorium pharaonis*, *Leptothorax interruptus*, and *Tetramorium caespitum*	32
III.	Eggs, larvae, and pupae of *Tapinoma erraticum*, *Acanthomyops niger*, *and Formica rufa*	34
IV.	Ergatandromorph of *Formica rufibarbis*, and Gynandromorph of *Formica sanguinea*	42
V.	Male, female, and worker of *Ponera coarctata*, *P. punctatissima*, and *Myrmecina graminicola*	82
VI.	Male and female of *Anergates atratulus*, and male, female, and worker of *Formicoxenus nitidulus* and *Monomorium pharaonis*	98
VII.	Male, female, and worker of *Solenopsis fugax* and *Myrmica sulcinodis*	114
VIII.	Male, female, and worker of *Leptothorax interruptus*, *L. acervorum*, and *Stenamma westwoodi*	160
IX.	Male, female, and worker of *Tetramorium caespitum* and *Tapinoma erraticum*	198
X.	Male, female, and worker of *Acanthomyops fuliginosus* and *A. alienus*	206
XI.	Carton nest of *Acanthomyops fuliginosus* and mounds of *A. flavus*	216
XII.	Nest of *Acanthomyops umbratus*	266
XIII.	Nests of *Formica rufa*	290
XIV.	Nests of *Formica rufa* v. *alpina* and *F. pratensis*	308
XV.	Male, female, and worker of *Formica pratensis*	310
XVI.	Nests of *Formica pratensis* and *F. exsecta*	318
XVII.	Male, female, and worker of *Formica rufibarbis*	370
XVIII.	Nests of *Formica exsecta* and *F. picea*	382

FIGURES PRINTED IN THE TEXT

	PAGE
Worker of *Formica pratensis*	2
Underside of head of *Formica pratensis* ☿	4
Mandible of *Formica pratensis* ☿	5
Maxilla of *Formica pratensis* ☿	5
Labium of *Formica pratensis* ☿	6
Thorax of *Streblognathus aethiopicus* ♂	7

LIST OF ILLUSTRATIONS

FIG.		PAGE
7.	Thorax of *Formica pratensis* ♂	8
8.	Fore-wing of *Formica* (*rufa* L.)	10
9.	Fore-wing of *Ponera* (*coarctata* Latr.)	11
10.	Fore-wing of *Myrmecina* (*graminicola* Latr.)	11
11.	Fore-wing of *Formicoxenus* (*nitidulus* Nyl.)	11
12.	Fore-wing of *Anergates* (*atratulus* Schenck)	11
13.	Fore-wing of *Monomorium* (*pharaonis* L.)	11
14.	Fore-wing of *Solenopsis* (*fugax* Latr.)	11
15.	Fore-wing of *Myrmica* (*ruginodis* Nyl.)	11
16.	Fore-wing of *Stenamma* (*westwoodi* West.)	11
17.	Fore-wing of *Leptothorax* (*interruptus* Schenck)	11
18.	Fore-wing of *Tetramorium* (*caespitum* L.)	11
19.	Fore-wing of *Tapinoma* (*erraticum* Latr.)	11
20.	Fore-wing of *Acanthomyops* (*alienus* Först.)	11
21.	Abdomen of *Ponera coarctata* ☿	12
22.	Abdomen of *Myrmica ruginodis* ☿	12
23.	Abdomen of *Tapinoma erraticum* ☿	12
24.	Abdomen of *Formica pratensis* ☿	13
25.	Abdomen of *Formica pratensis* ♂	13
26.	♂ genitalia of *Formica rufibarbis* (dorsal)	14
27.	♂ genitalia of *Formica rufibarbis* (ventral)	14
28.	Stipes, volsella, and sagitta of *Formica rufibarbis* (dissected out)	15
29.	♂ genitalia of *Ponera punctatissima*	15
30.	♂ genitalia of *Myrmica scabrinodis*	15
31.	Internal structure of *Myrmica rubra* ☿	16
32.	Gizzard of *Formica pratensis* ☿	17
33.	Gizzard of *Tapinoma erraticum* ☿ (anterior view)	18
34.	Poison apparatus of *Formica rufibarbis* ☿	19
35.	Poison apparatus of *Bothriomyrmex meridionalis* ☿	20
36.	Poison apparatus of *Myrmica laevinodis* ☿	21
37.	Repugnatorial glands of *Tapinoma erraticum* ☿	21
38.	Sketch to show position of repugnatorial glands of *Tapinoma erraticum* ☿	22
39.	Reproductive organs of *Myrmica rubra* ♀	23
40.	Ovaries of pseudogyne of *Formica rufa*	23
41.	Reproductive organs of *Myrmica rubra* ♂	24
42.	Brain, etc., of *Acanthomyops fuliginosus* ☿	25
43.	Head of larva of *Myrmica scabrinodis*	31
44.	Hairs on *Myrmica* larva	32
45.	Ergatandromorph of *Myrmica scabrinodis*	36
46.	Ergatandromorph of *Formica sanguinea*	37
47.	Mermithogyne of *Acanthomyops flavus*	38
48.	Pseudogyne of *Formica sanguinea*	39
49.	Pseudogyne of *Formica rufa* var. *rufo-pratensis*	40
50.	Pterergate of *Myrmica scabrinodis*	41
51.	Stand for "Lubbock" nests	59
52.	Four-chambered "Janet" plaster nest	60

FIG.		PAGE
53.	"Santschi" observation-nests	62
54.	"Crawley-Lubbock" observation-nest	62
55.	"Donisthorpe" observation-nest	64
56.	Head of *Ponera coarctata* ♀ and *P. punctatissima* ♀	68
57.	Epinotum and pedicel of *Myrmecina graminicola* ☿	80
58.	Pedicel of *Formicoxenus nitidulus* ☿	90
59.	Head and thorax of *Formicoxenus nitidulus* ♂	90
60.	*Monomorium pharaonis* ☿	104
61.	Antenna of *Solenopsis fugax* ☿	110
62.	Antenna of *Solenopsis fugax* ♂	110
63.	Epinotum, spines, and pedicel of *Myrmica laevinodis* ☿	119
64.	Epinotum, spines, and pedicel of *Myrmica ruginodis* ☿	125
65.	Antenna of *Myrmica ruginodis* ☿	125
66.	Antenna of *Myrmica ruginodis* ♂	126
67.	Antenna of *Myrmica sulcinodis* ☿	132
68.	Antenna of *Myrmica scabrinodis* ☿	136
69.	Antenna of *Myrmica scabrinodis* ♂	136
70.	Antenna of *Myrmica scabrinodis* v. *sabuleti* ☿	143
71.	Antenna of *Myrmica scabrinodis* v. *sabuleti* ♂	143
72.	Antenna of *Myrmica lobicornis* ☿	146
73.	Antenna of *Myrmica lobicornis* ♂	146
74.	Scape of antenna of *Myrmica schencki* Emery in Profile	150
75.	Head of *Stenamma westwoodi* ☿	155
76.	*Stenamma westwoodi* ☿	155
77.	Pedicel of *Leptothorax nylanderi* ♂	174
78.	Scutellum and epinotum of *Leptothorax tuberum* ♀	182
79.	Pedicel of *Leptothorax tuberum* ♂	183
80.	Scutellum and epinotum of *Leptothorax interruptus* ♀	186
81.	Pedicel of *Leptothorax interruptus* ♂	186
82.	Head and shoulders of *Tetramorium caespitum* ☿	191
83.	*Acanthomyops fuliginosus* ♀ with gaster distended with eggs	213
84.	*Acanthomyops niger* ♀	230
85.	Scales of *Acanthomyops flavus* ☿, *A. umbratus* ☿, and *A. mixtus* ☿	255
86.	*Acanthomyops umbratus* ♀	263
87.	*A. mixto-umbratus* ☿ with patches of algae on body and legs	275
88.	Scale of *Formica rufa* ☿	287
89.	Head of *Formica rufa* ☿ and *F. rufa* v. *alpina* ☿	307
90.	Head of *Formica exsecta* ☿	316
91.	Clypeus of *Formica sanguinea* ☿	324
92.	Side view of thorax of *Formica rufibarbis* ☿	369
93.	Thorax and scale of *Formica gagates* ☿ and *Formica picea* ☿	378

"To him who is satisfied with amassing collections of curious objects, simply for the pleasure of possessing them, such objects can afford, at best, but a childish gratification, faint and fleeting; while he who extends his view beyond the narrow field of nomenclature, beholds a boundless expanse, the exploring of which is worthy of the philosopher, and of the best talents of a reasonable being."—BURCHELL, "Southern Africa" 1, 505 (1822).

"Field study of the Formicidae is certainly becoming much more interesting and precise through our increasing knowledge of dulosis and temporary social parasitism, since every ant colony examined no longer represents to the observer merely a meaningless aggregate of individuals, but a definite stage in the life-cycle of a colonial organism. Thus the myrmecologist is prompted to attack a host of fascinating problems suggested by the origin, development and decline, both onto- and phylogenetic, of a living community and the instinctive processes involved in the numerical regulation of its polymorphic components."—WHEELER, "Bull. Amer. Mus. Nat. Hist." 24, 645 (1908).

"Myrmecology has been more fortunate than many other branches of entomology in the men who have contributed to its development. These have been actuated, almost without exception, not by a mania for endless multiplication of genera and species, but by a temperate and philosophical interest in the increase of our knowledge."—WHEELER, "Ants," 1910, p. 123

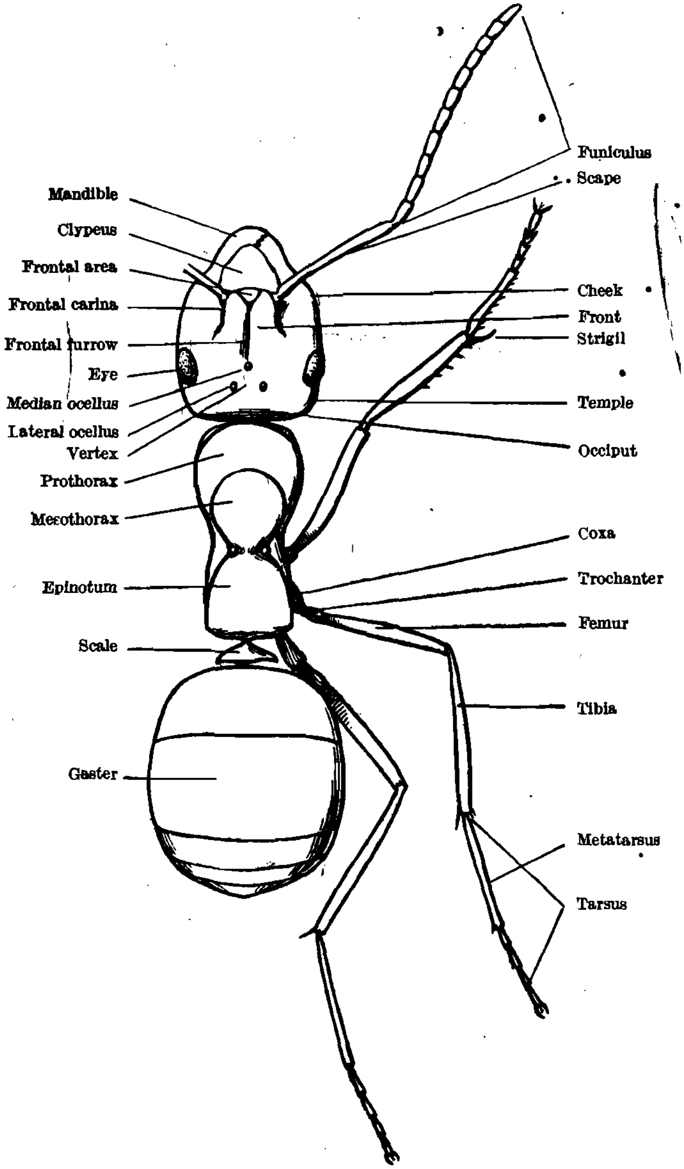

Fig. 1. Worker of *Formica pratensis*

AGRICUL ... COIMBAT

BRITISH ANTS.

INTRODUCTORY.

EXTERNAL STRUCTURE.

ITS can be distinguished from all the other members of the ler Hymenoptera by the construction of the abdomen, which divided into two very distinct regions, a slender very movable *licel* of one or two joints (the *petiole* and *post-petiole—the petiole th a scale or node on the upper surface*), and a larger posterior rtion, the *gaster*.

In certain low forms in the *Ponerinae* the construction of the domen comes nearer to that of some of the Fossores, but such ms, not occurring in Britain, do not concern us here. The con-tency of the chitinous integument of the body is very variable, ing thicker, harder, and more brittle in species of the more imitive groups, *Ponerinae* and *Myrmicinae*, and thinner, softer, d more flexible in the more recently developed groups, *Dolich-rinae*, *Formicinae*, etc.

Some species are glabrous, and shining; others pilose and bescent, opaque, rugose, punctured, striate, etc.

The hairy covering, when present, consists of (1) pilosity, viz. ger hairs, erect or sub-erect; and (2) pubescence, viz. short sely applied hairs which cover parts, or the whole, of the body.

The Head.

The head varies considerably in shape, it may be three-cornered, ir-cornered, round, oval, elongate, transverse, etc. The organs ached to it are the mandibles and other parts of the mouth, the es and the antennae.

The head above terminates anteriorly with the *clypeus*, an movable plate varying in shape. The *genae*, or cheeks, are situ-d on either side of the clypeus extending between the eyes and e mandibles. Posterior to the clypeus in nearly all cases is a all space, usually triangular in shape, which is called the *frontal a*; and behind this an impressed longitudinal line, the *frontal*

furrow; is often present, which runs back towards the base of the head. The *front* is the region lying between the *frontal carinae* (a pair of ridges, situated on the inner side of the insertion of the antennae), and is bounded anteriorly by the clypeus. Posteriorly it passes indefinitely into the *vertex* of the head and the temples; the latter lie above and behind the eyes. The *occiput* is the short region between the vertex of the head and the narrow opening (the foramen) beneath at its junction with the thorax.

The ventral surface of the head between the labium and the above-mentioned opening is the *gula* or throat, it is generally divided by a longitudinal suture.

The compound or lateral eyes are situated on either side of the head; the simple or median eyes, *stemmata*, or *ocelli*, when present,

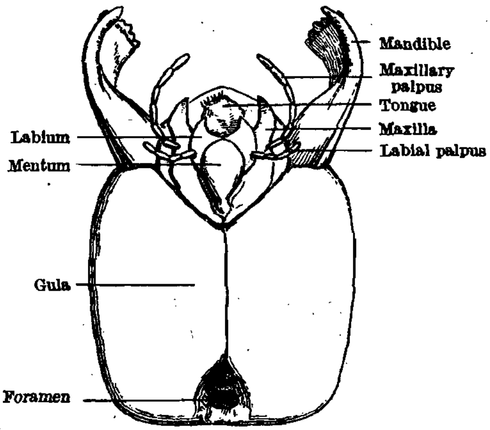

Fig. 2. Underside of head of *Formica pratensis* ☿.

are three in number, and are placed triangularly on the front of the head. Both kinds of eyes are most highly developed in the males, and least in the workers, the ocelli being wanting in the latter of some species.

The facets of the compound eyes vary greatly in size and number in different species. It has been estimated that the lateral eye in the worker of *Ponera punctatissima* only consists of one facet; in the worker of *Solenopsis fugax* from 6–9, in the female 200, and in the male 400; *Tapinoma erraticum*—worker 100, female 260, male 400; *Formica pratensis*—worker 600, female 830, male 1200.

The *mandibles* are very variable in structure, being sometimes long, narrow and pointed, but often broad and massive, having three borders, an external, an internal, and a terminal, the latter being often more or less strongly toothed. The mandibles can be opened and closed independently of the other parts of the mouth.

The *maxillae* and *labium* are situated beneath the very small *labrum* and keep the mouth completely closed except when the ant is feeding.

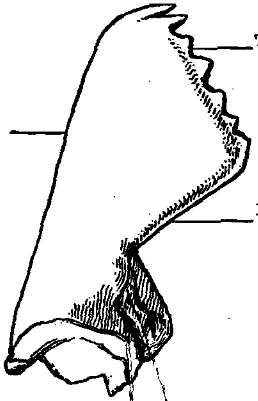

Fig. 3. Mandible of *Formica pratensis* ☿.

The maxillae consist of a *cardo* or hinge, a *stipes* or stem, a *cinia* or inner-blade, a *galea* or outer-blade, and a *palpus* which ay consist of from one to six joints.

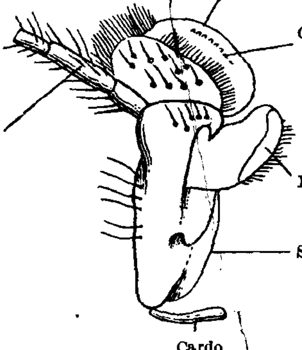

Fig. 4. Maxilla of *Formica pratensis* ☿.

The outer-blade is furnished with gustatory papillae, and a ro bristles used in cleaning the legs, etc.

The labium consists of a *submentum* or hind-chin, a *mentum* o hin, the *hypopharynx* and *paraglossae** which are double, the *gloss*

* According to Bugnion these are the "râteaux" or "rastelli" of d uysson, and are incorrectly called paraglossae by myrmecologists. [Bul ocn. Nat. Nice 12 22 (1925).]

or tongue, and the *labial palpi* which may consist of from one to four joints. The tongue is covered with fine transverse ridges ; it can be protruded, and with it the ant rasps and licks up its food, and cleans itself and its companions.

The opening of the salivary duct is situated at the base of the tongue. The hypopharynx covers the mentum and paraglossae, and possesses two rows of bristles directed backwards, which are

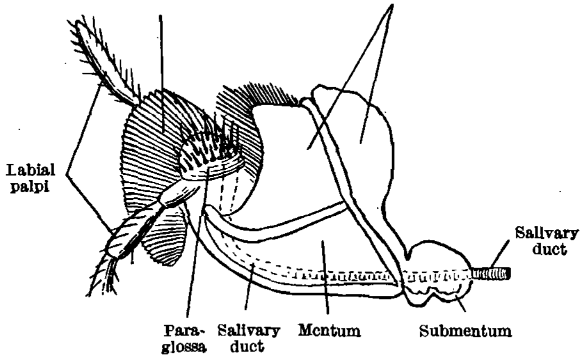

Fig. 5. Labium of *Formica pratensis* ☿.

used for firmly holding the food. The roof of the mouth is formed by the labrum, which is bilobed, and is concealed by the clypeus.

The *antennae*, which are elbowed, are inserted on either side of the frontal carinae ; the first joint is the *scape*, which is usually long, except in the males of a few species, and the remaining joints form the *funiculus*, which is sometimes clubbed. The number of joints in the antennae of ants varies from four to thirteen—the male usually possessing one more joint than the female or worker. No British ant has less than ten joints to its antennae.

Table showing the number of joints to the antennae of the male, female and worker in British genera.

	♂	♀	☿
Ponera	12–13	12	12
Myrmecina	13	12	12
Formicoxenus . . .	12	11	11
Anergates	11	11	—
Monomorium . . .	13	11–12	11–12
Solenopsis	12	11	10
Myrmica	13	12	12
Stenamma	13	12	12
Leptothorax	12–13	11–12	11–12
Tetramorium . . .	10	12	12
Tapinoma	13	12	12
Acanthomyops . . .	13	12	12
Formica	13	12	12

The Thorax.

The thorax is divided into four segments, the prothorax, mesothorax, metathorax, and epinotum. The epinotum (which is the metanotum of some earlier writers and the propodeum of others) was the first abdominal segment of the larva, which has been fused to the thorax during pupation.

In the primitive form, all the component parts of the thorax of the male ant are distinctly separated by sutures.

The *prothorax* is small and is divided into the *pronotum* and *prosternum*; the former comprises both dorsally and laterally the greater part of the prothorax, while the latter is small and narrow, and to it the coxa of the fore leg is articulated.

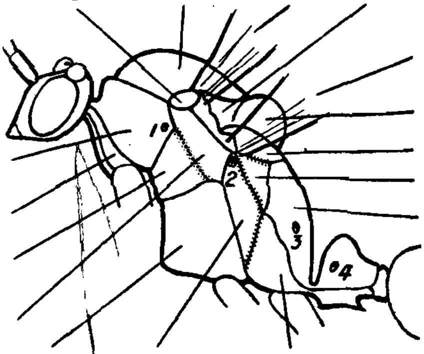

Fig. 6. Thorax of *Streblognathus aethiopicus* ♂. (Emery.)
1, 2, 3, and 4 stigmata of meso- and metathorax, epinotum, and petiole.

The *mesothorax* is large and bears the fore-wings; its anterior dorsal portion, the *scutum* of the mesonotum, often spoken of as the mesonotum, bears in many male ants a Y-shaped furrow, called the *Mayrian furrow*, and on either side is a longitudinal suture, the *parapsidal furrow*, which separates off the area known as the *parapsis*. The *prae-scutellum* (=*paraptera* of Emery) of the mesothorax, is situated at the posterior end of the scutum behind the articulation of the fore-wings. Covering the insertion of the fore-wing a chitinous scale, the *tegula*, occurs. The *scutellum*, a large semicircular plate, is situated between the prae-scutellum and the metanotum. The coxa of the intermediate leg is articulated to the mesosternum; between this and the pronotum is the *episternite* of the mesothorax, and above the latter is the *epimeron* of the mesothorax.

The *metanotum*, the dorsal part of the metathorax, consists of a narrow band between the scutellum and the epinotum, and on either

side between the scutellum and the metanotum lies the *post-scutellum*, or *paraptera* of the metathorax. The coxa of the hind-leg is articulated to the metasternum, and the ventral portion of the metathorax is divided into areas as in the mesothorax, viz. the *epimeron*, the *episternite* and the *sternite*. The hind-wing is inserted between the post-scutellum and the epimeron of the metathorax. The *epinotum*, which is really the first abdominal segment, is bordered by the epimera of the metathorax above, and the sternites of the metathorax below.

Three *stigmata*, or spiracles (orifices of tracheae) occur on either side of the thorax, the first close to the junction between the meso-thorax and pronotum, the second below the insertion of the hind-wing, and the third on the epinotum.

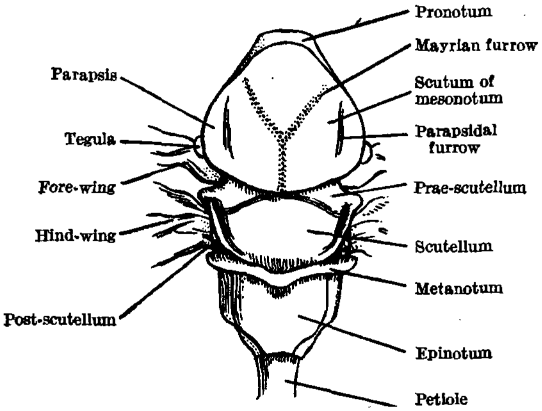

Fig. 7. Thorax of *Formica pratensis* ♂.

The thorax in the males and females of most ants is generally more simple than in this primitive form on account of the fusion of the epimera and episterna with each other, and also with meso- and metathorax, and epinotum.

The female thorax has the same divisions as the male, but is more robust and the Mayrian furrows are never present. In the workers, being wingless, the meso- and metathorax are greatly reduced, and in the higher and more recent genera, such as *Formica*, the thorax apparently consists of three segments only, the pronotum, mesonotum and epinotum, owing to the disappearance of the scutellum, the paraptera and the metanotum.

The legs of ants are not very variable and always consist of the same number of joints—the *coxa*, *trochanter*, *femur*, *tibia*, and a five-jointed *tarsus*, the first joint of which is always long, especially in the intermediate and posterior legs, and is called the *metatarsus*. The last joint of the tarsus carries two claws (*unguiculi*) which

are generally simple, but sometimes toothed or pectinate. The apices of the tibiae are often armed with movable spurs (*calcaria*), which may be simple in the intermediate and posterior pairs, but if present are always large and pectinate in the anterior ones. These latter are called *strigils*, and are curved and fringed with bristles on their inner side. Bristles also occur on the metatarsus, opposite to those on the strigil, and the ants clean their antennae by drawing them between these bristles.

The wings of ants have not been used in classification to the same extent as in other families of the Hymenoptera, chiefly because the workers, which are most often found, are wingless, and the females, which lose their wings after the marriage flight, are more frequently taken in this "deälated" condition; moreover, the venation of the wings may vary considerably, even in males and females from the same colony. Adolph (Verh. Ver. Rheinl, **37**, 35–53 (1880)) examined a large number of male and female *Acanthomyops umbratus* Nyl., taken by him during a marriage-flight, and found that over 80 per cent of the specimens varied in the neuration of their wings.

The longitudinal veins of the fore-wings have been named by Emery (1913) as follows:—

Costa, subcosta, pterostigma (=*stigma* Linnaeus), *medius, brachius, radius,* and *cubitus.*

The transverse veins: *transversomedialis, basalis* (or *discoidalis*), first and second *cubitalis*, and *recurrens* (or *medialis*).

The cells: *costal, median, submedian, radial, cubital* 1, 2, and 3, *discoidal* 1 and 2. Not all, however, of these cells and veins actually occur in most British genera (cf. the following figures).

The Abdomen.

The *abdomen* is highly specialized, and in most ants it is sharply divided into a *pedicel* and *gaster*. The pedicel may consist of one joint, the *petiole*, or two joints, the *petiole* and *post-petiole*; it is very mobile and is articulated anteriorly to the epinotum and posteriorly to the gaster. When the pedicel is one-jointed it usually consists dorsally of a more or less high *scale* of variable shape and thickness.

The petiole is morphologically the second abdominal segment, for actually, as we have seen, the epinotum is the first, and consequently the first gastric segment is the third abdominal one. When the pedicel is two-jointed it consists of two nodiform segments, and the first gastric segment is therefore the fourth abdominal one.

The gaster varies in shape, being round, oval, long, or cordiform, etc., and shows five segments in the worker and female, and six in the male when the pedicel is one-jointed, and four in the worker and female and five in the male, when two-jointed. Morphologically

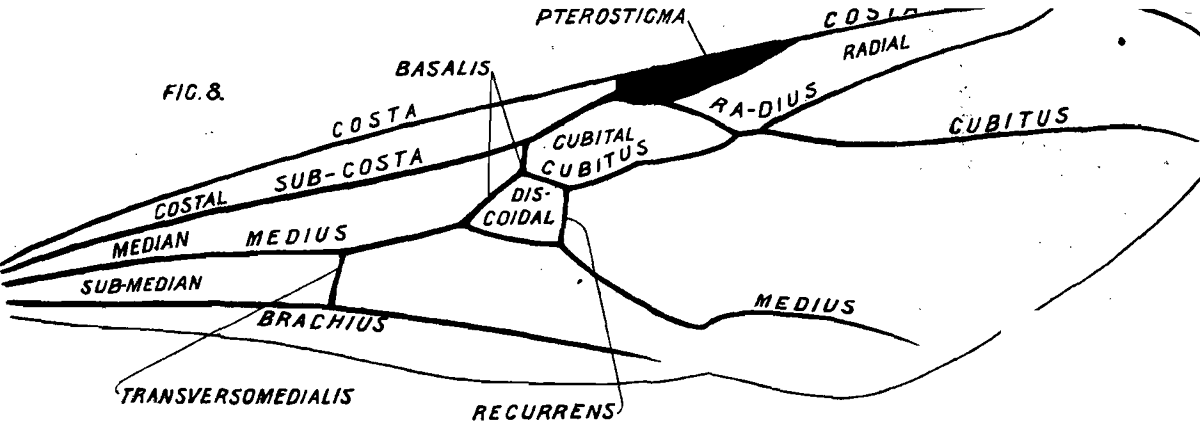

Fig. 8. Fore-wing of *Formica* (*rufa* L.).

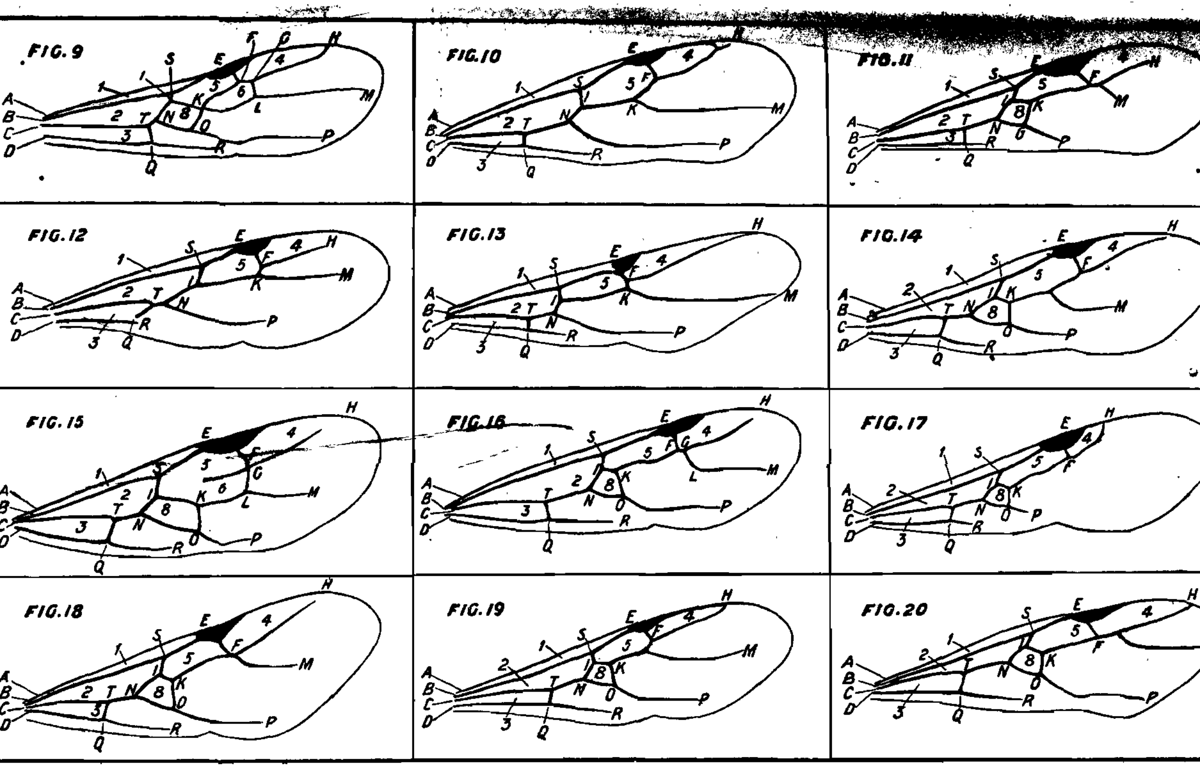

Fig. 9. *Ponera* (*coarctata* Latr.).
Fig. 10. *Myrmecina* (*graminicola* Latr.).
Fig. 11. *Formicoxenus* (*nitidulus* Nyl.).
Fig. 12. *Anergates* (*atratulus* Schenck).
Fig. 13. *Monomorium* (*pharaonis* L.).
Fig. 14. *Solenopsis* (*fugax* Latr.).
Fig. 15. *Myrmica* (*ruginodis* Nyl.).
Fig. 16. *Stenamma* (*westwoodi* West.).
Fig. 17. *Leptothorax* (*interruptus* Schenck
Fig. 18. *Tetramorium* (*caespitum* L.).
Fig. 19. *Tapinoma* (*erraticum* Latr.).
Fig. 20. *Acanthomyops* (*alienus* Först.).

Longitudinal veins.—Costa A E (sometimes to H). Subcosta B S E. Pterostigma E. Medius C T N O P. Brachius D Q R. Radius E F Cubitus I K M. Transverse Veins.—Transversomedialis T Q. Basalis S I N. 1st Cubitalis F K. 2nd Cubitalis G L. Recurrens K O. Cells.—Costa Median 2. Submedian 3. Radial 4. Cubital one 5. Cubital two 6. Discoidal 8.

the gaster consists of eight segments when the pedicel is one-jointed and seven when two-jointed; but the terminal segments are very small and are telescoped into those in front of them.

In those ants which possess the power of stridulating, the sound-

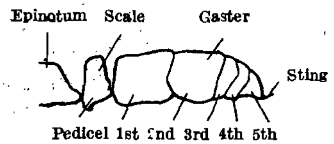

Fig. 21. Abdomen of *Ponera coarctata* ☿.

producing organ is situated at the extreme base of the first gastric segment. This organ consists of a file, formed by very fine transverse ridges, situated at the base of the segment, in the centre of its dorsal area. The edge of the preceding segment is sharp, turning

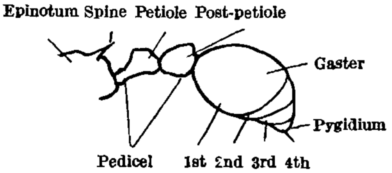

Fig. 22. Abdomen of *Myrmica ruginodis* ☿.

slightly downward, or inward, and is thus able to scrape the file, when the two segments move on each other. These structures are present in the *Ponerinae* and *Myrmicinae*, but appear to be absent in the *Formicinae* and *Dolichoderinae*. The sculpture, however,

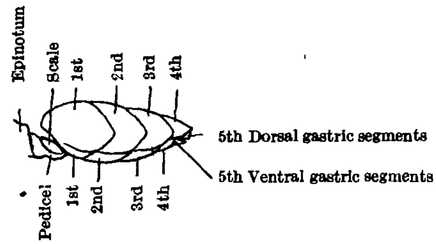

Fig. 23. Abdomen of *Tapinoma erraticum* ☿.

of the corresponding surfaces in the genus *Acanthomyops*, etc., is modified, and though there is no true stridulating organ, it is probable that some sounds may be produced when these surfaces are rubbed together.

The apical segment of the gaster is called the *pygidium*, its dorsal

plate being the *epipygium*, and the ventral one the *hypopygium* ; the former is nearly always visible from above, except in some genera where it is entirely hidden beneath the preceding segment. The last segments hold the genitalia in the two sexes, and also enclose the sting of the females and workers in such ants as possess one.

The genital armature of the male consists of the following parts : The *Annular Lamina* is a ring which forms the base of the whole apparatus. The *External Paramera* consist of the outer and inter-

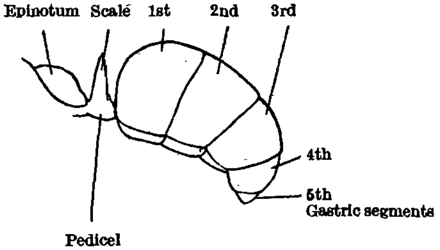

Fig. 24. Abdomen of *Formica pratensis* ☿.

mediate pairs of appendages ; the outer pair are the *Stipites*, which act as claspers and are often furnished with hairs. In some genera the basal parts of the stipites consist of more or less elongate, triangular, oval or semicircular lobes, which are called the *Squamulae*. These sometimes look as if they were separate plates applied to the stipites, but this is not the case as they are actually part of them.

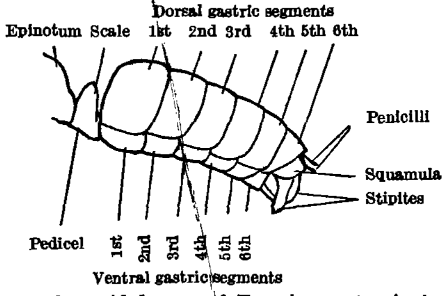

Fig. 25. Abdomen of *Formica pratensis* ♂.

The median pair are known as the *Volsellae ;* these are sometimes more or less divided into two pairs, one of which is then called the *Laciniae* and the other the *Volsellae*. The volsellae and laciniae also probably act as claspers.

The *Internal Paramera* consist of the innermost pair of appendages, the *Sagittae*, which are connected together by a membrane, the *Spatha ;* and the sagittae + the spatha function as a penis.

The sagittae often have serrated edges which probably serve to hold them in position during copulation.

Of these three pairs of appendages the stipites enclose the volsellae and the latter enclose the sagittae and spatha.

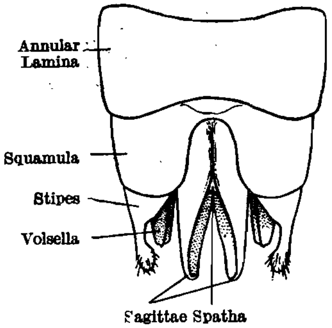

Fig. 26. ♂ *genitalia of Formica rufibarbis (dorsal).*
(Donisthorpe.)

The *Subgenital Lamina* is a plate situated beneath the genitalia, and forming in fact the ninth ventral segment of the abdomen. It is sometimes pointed, forked, or rounded, and presents valuable distinctive characters in some genera.

Finally there is a small pair of hairy appendages, the *Penicilli*

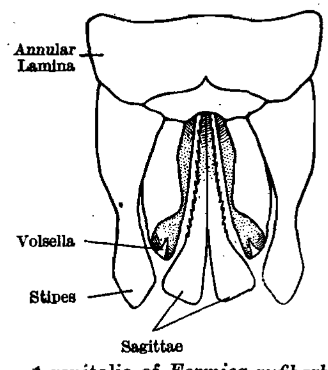

Fig. 27. ♂ genitalia of *Formica rufibarbis* (ventral).
(Donisthorpe.)

which are attached to the tenth dorsal segment of the abdomen. They are not present in some genera such as *Anergates, Dorylus,* etc.; and in *Prenolepis* they are present in some species, and wanting in others, and are consequently valuable for classification purposes. They are stated to represent the Cerci in *Blatta* (the "Cockroach"), etc., but this does not seem to be absolutely certain.

The *sting* is retractile, and its size, in different species, varies greatly, not always in proportion to the size of their bodies. It consists of a single grooved piece, the *gorgeret*, on which run the *stylets*,

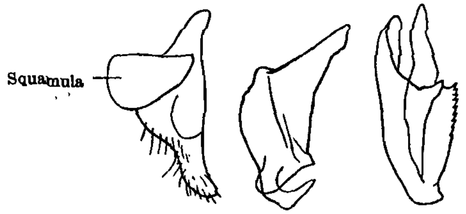

Fig. 28. Stipes, Volsella, and Sagitta of *Formica rufibarbis* (dissected out). (Donisthorpe.)

a pair of smooth, slender, pointed appendages. When at rest the stylets do not extend beyond the gorgeret, but when an ant uses

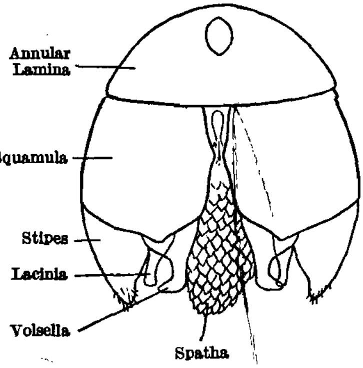

Fig. 29. ♂ genitalia of *Ponera punctatissima*.

its sting, it thrusts the whole apparatus into the object attacked, and the stylets are pushed alternately further into the wound, beyond the tip of the gorgeret.

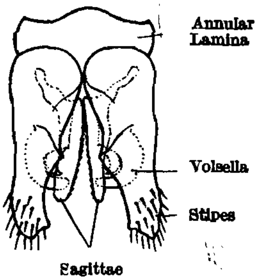

Fig. 30. ♂ genitalia of *Myrmica scabrinodis*. (C

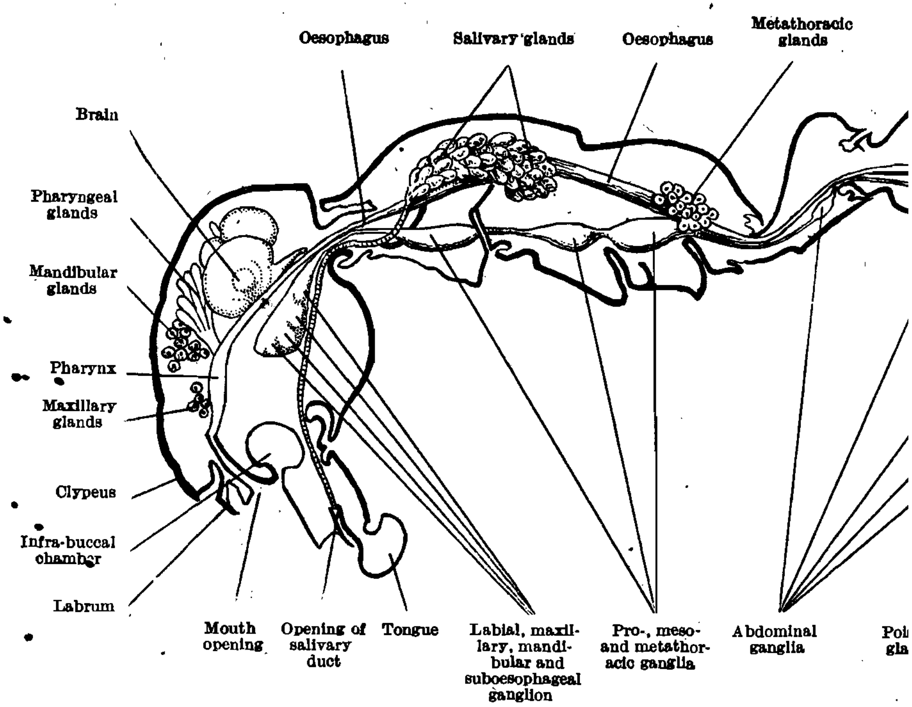

Fig. 31. Internal structure of *Myrmica rubr*

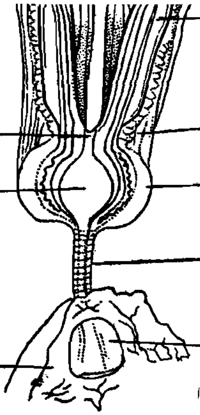

Fig. 32. Gizzard of *Formica pratensis* ☿. (Forel.)

body, the " Boulettes de nettoyage " of Janet, which retains the shape of the infra-buccal chamber.

After this pellet has been ejected it must still contain a considerable amount of nutritious matter, for, as I have shown, it forms the chief, if not the only, food of the larva of the Dipterous genus *Microdon,* and also part of that of the beetle larva of *Clythra 4 punctata*. Moreover, Wheeler discovered that in the larvae of all four genera of his subfamily *Pseudomyrminae*, the swollen ventral portion of the first abdominal segment, just behind the mouth, forms a pocket, the trophothylax, in which the workers place the pellet from their own infra-buccal chamber; and no other ants have been observed to feed their larvae in this way, but eventually

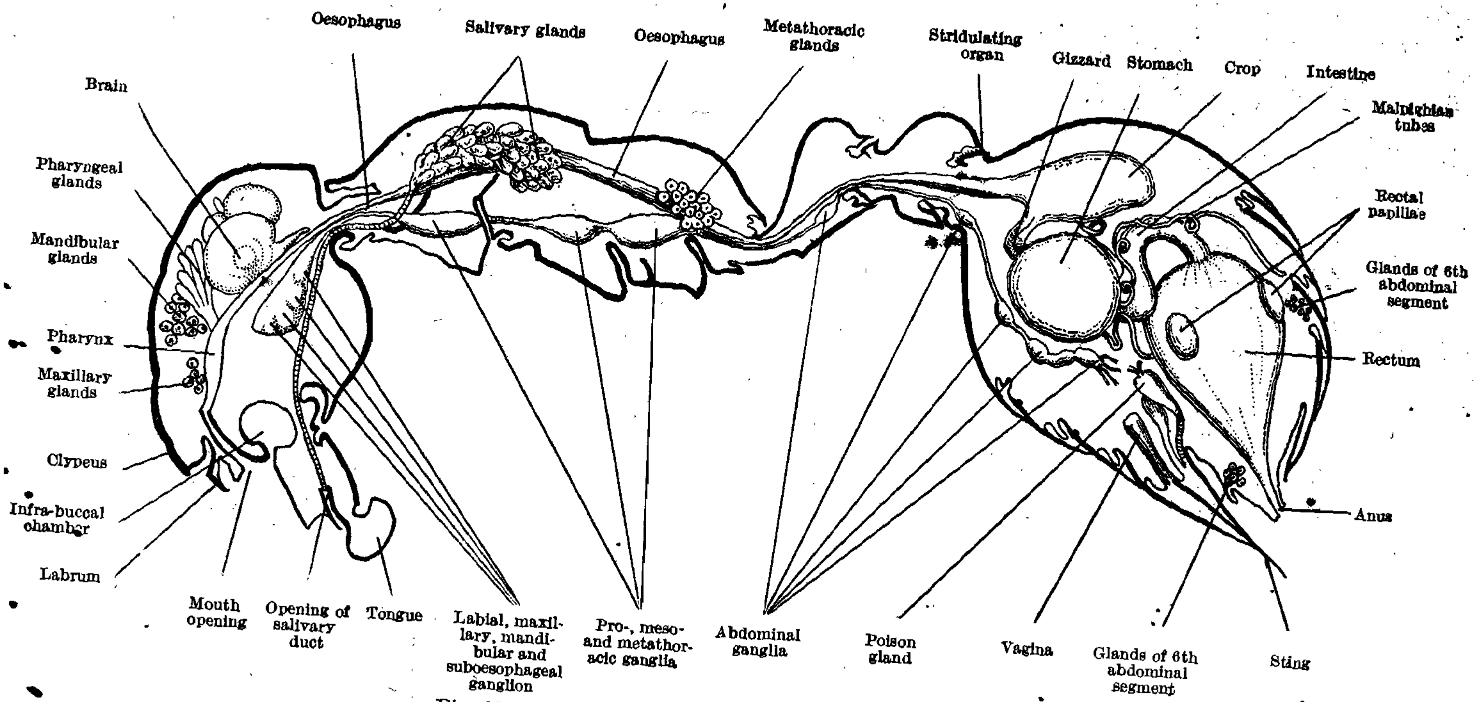

Fig. 31. Internal structure of *Myrmica rubra* ☿. (Janet.)

INTERNAL STRUCTURE.

The alimentary canal consists of a mouth opening and buccal rts, an infra-buccal chamber, pharynx, oesophagus, crop, gizzard, omach, intestine, rectum and anus.

The *infra-buccal chamber* is a spherical cavity situated below the harynx, and forms a receptacle for the solid and semi-solid parts the food rasped off by the ant's tongue, and also for foreign atter scraped off the ant's body by its tongue and strigils. Any ices that remain in these substances are extracted and sucked to the pharynx, the residue being ejected in the form of a solid

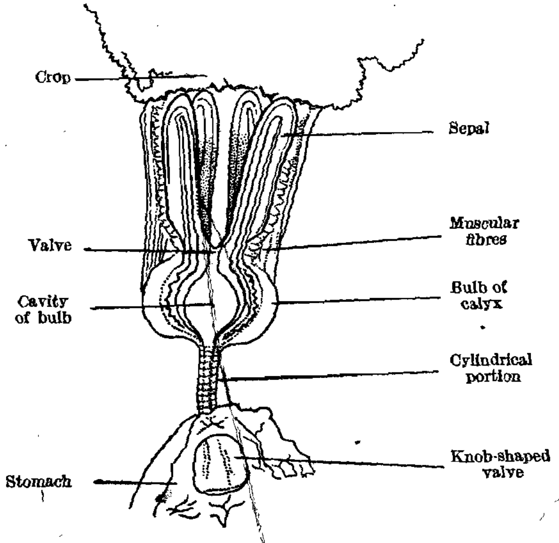

Fig. 32. Gizzard of *Formica pratensis* ☿. (Forel.)

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spit it out. The mouth of the larva possesses a singular structure, the trophorhinium, with which they thoroughly grind up the pellet. This structure is also present in other ant larvae, and may be used as a stridulating organ.

The *pharynx* is situated in the head and is a flattened cavity with very muscular walls which open and shut, forcing the liquid food into the oesophagus.

The *oesophagus* is a long tube connecting the pharynx with the abdomen; it is only feebly muscular.

The *crop* is situated in the gaster, consisting simply of an enlargement of the oesophagus. It forms a reservoir for the retention of the liquid food, and is capable of great distension—the "Honey-Ants of the Garden of the Gods" represent the extreme form of this phenomenon. Forel has called it the social stomach, as the food it contains is used to feed the brood, and the other ants of the colony, by regurgitation.

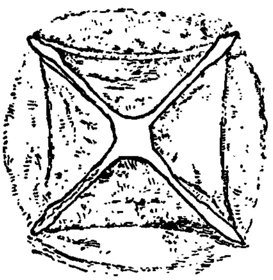

Fig. 33. Gizzard of *Tapinoma erraticum* ☿ (anterior view).

The *gizzard* connects the crop with the stomach proper; it has been called the pumping-stomach, is very variable in form, and affords valuable characters, which can be used to differentiate genera, and even subfamilies. It is composed anteriorly of a cup-shaped portion, the *calyx*, the chitinous walls of which are formed by eight bands; the four thicker ones, the *sepals*, contract at their posterior end to form a valve. The gizzard then becomes dilated into a bulb, the pumping-stomach proper; this is followed by a cylindrical portion which enters the true stomach, where it terminates in a knob-shaped valve. The walls of the gizzard, and especially the bulb, are provided with very powerful muscles. The gizzard is more simple in the *Ponerinae*, and *Myrmicinae*, and more complicated in the *Dolichoderinae* than in the *Formicinae*.

The *stomach* proper is a sac in which the food it receives is digested; it is not capable of much distension, and does not possess any chitinous lining.

The *intestine* is a more or less wrinkled tube which connects the

omach with the rectum, and near its anterior end, where it forms valve, the *Malpighian tubes* or uninary vessels are inserted.

The *rectum* is large, tapering towards its posterior end, where it rminates in the anus; in it the faeces and urinary excretions e collected.

The *anus* varies in shape in different genera; it is provided with phincter muscle, and is sometimes fringed with hairs.

The Glands.

I. Glands in the Head.

The *antennary glands* consist of a few cells, the slender ducts of ich open on a small space, situated in a depression at the base each antenna.

The *maxillary glands* comprise two groups of cells placed above

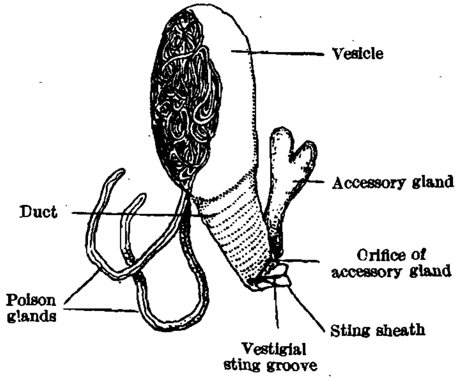

Fig. 34. Poison apparatus of *Formica rufibarbis* ☿. (Forel.)

buccal tube, their separate ducts opening on a "cribellum" in lateral wall of the tube.

The *mandibular glands* are large and consist of a number of cells either side of the head, their ducts opening separately on a bellum at the base of the mandibles. These glands supply the nent which ants use in constructing carton, and plastering ticles of earth together, etc.

The *pharyngeal glands* are finger-shaped and consist of two ups, which extend in front of and over the brain, and open by air of orifices into the alimentary canal.

2. Thoracic Glands.

The *labial*, or *salivary glands*, are situated in the thorax, though y really belong to the mouth parts. They are large and paired, l are connected by a single duct which opens on the labium. ey are derived from the spinning glands of the larva.

The *metathoracic glands* consist of numerous cells, their ducts

opening through a sieve-like membrane into a chamber filled with air. The orifice of this chamber and the cribellum are sometimes furnished with hairs. Janet has suggested that the secretion from these glands gives to the ant's body the "nest-aura," by means of which the ants in a colony recognize their fellows.

The *metatarsal glands* are situated in the fore-legs, at the base of the strigil.

3. Abdominal Glands.

The rectum is furnished with three *rectal papillae*, or glands, the central one being situated on the dorsal, the outer pair on the lateral, surfaces.

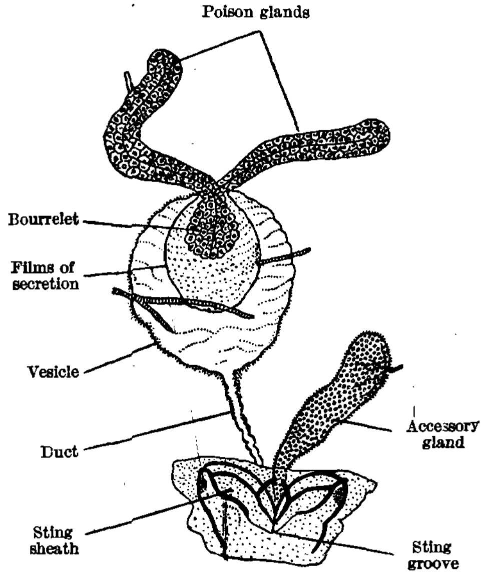

Fig. 35. Poison apparatus of *Bothriomyrmex meridionalis* ☿ (a Dolichoderine ant). (Forel.)

The glands belonging to the sixth abdominal segment (intrasegmental "hautdrüsen" Escherich) consist of small clusters of cells, their ducts opening on the dorsal membrane below the segment, and others are found on the ventral membrane.

The poison apparatus is a complicated structure made up of the *poison glands*, the *vesicle*, or poison sac, the *duct* of the vesicle with, or without, a sting, and the *accessory gland*. This apparatus occurs in the workers and females of all ants, and is situated in the posterior part of the gaster, below the rectum. Forel distinguished this apparatus into two types—the Pulvinated and the Bourreleted—according to the form and arrangement of the different parts.

The Pulvinated type is the more complicated; it is confined to the *Formicinae*, and in these forms more acid is stored. The two free poison glands enter the distal end of the vesicle, where they become a single tube, which is curled up into innumerable windings, forming a cushion on the inside of the dorsal wall of the

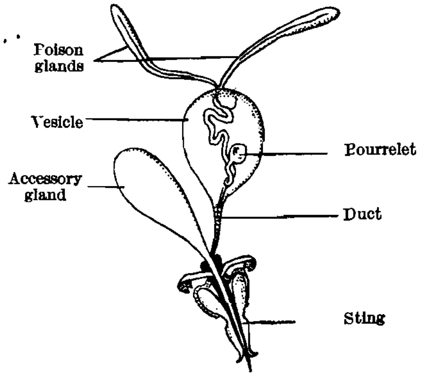

Fig. 36. Poison apparatus of *Myrmica laevinodis* ☿. (Forel.)

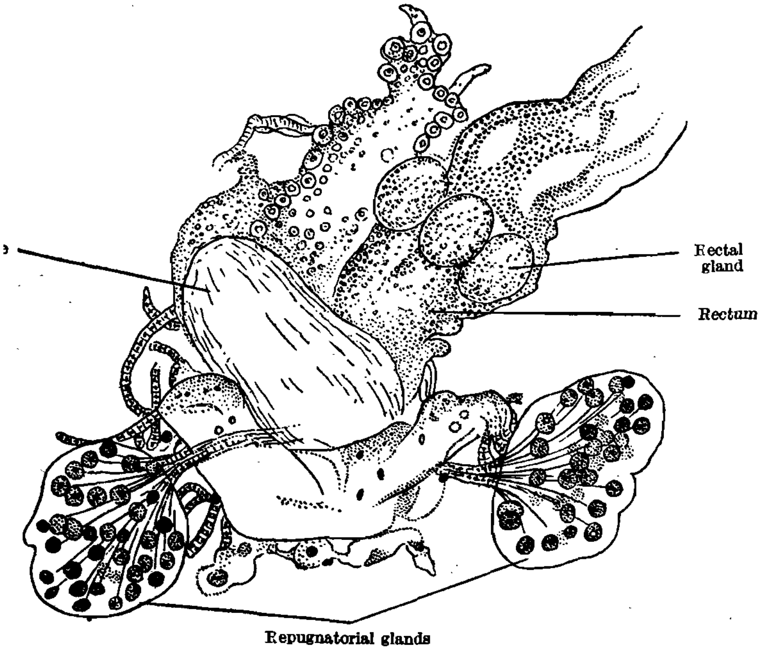

Fig. 37. Repugnatorial glands of *Tapinoma erraticum* ☿.

vesicle. This tube when unravelled is, according to Forel, quite twenty centimetres in length. The duct of the vesicle opens in a large orifice between certain vestiges of the almost obsolete sting. The accessory gland opens into the duct of the vesicle, near its termination. Janet suggests that the secretions of the accessory gland, which are alkaline in character, are used to neutralize the effect of the acid poison which may adhere to the ant's own body, after it has used its poison, or sting, against an enemy.

In the Bourreleted type the apparatus is much simpler, the vesicle is smaller and more globular, and its duct is more slender. The free poison glands unite and enter the vesicle, where they form a not very winding tube which ends in a sort of swelling or "bourrelet."

When a sting is present, the acid is injected directly into the

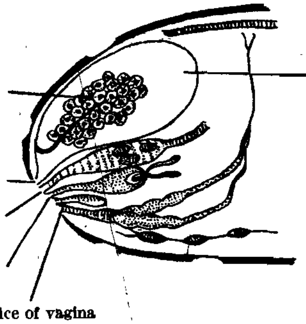

Fig. 38. Sketch to show position of Repugnatorial glands of *Tapinoma erraticum* ☿.

body of an enemy, but when absent, the latter is sprayed over him, or into a wound inflicted by the mandibles.

The *anal*, or *repugnatorial glands*, are only present in the workers and females of the *Dolichoderinae*. They consist of two grape-like clusters of cells; their ducts open into two large vesicles or sacs, which act as reservoirs for the secretions of these glands. This apparatus is situated above the rectum, and opens just above the anus. The secretion is used to protect the ant against other ants, and enemies; it is very powerful, and in *Tapinoma* it possesses a very strong and distinctive odour.

Reproductive Organs.

The reproductive organs in the female ant consist of a *vagina*, *uterus*, *bursa copulatrix*, *receptaculum seminis* and *ovaries*. The vagina, which is short, opens into the uterus, its external opening consisting of a transverse slit situated in front of the sting, or its vestige, on the sternal membrane of the seventh abdominal segment.

he bursa copulatrix is a sac, or copulatory pouch situated on the orsal wall of the vagina. The uterus is formed by the junction of e two oviducts of each ovary, and upon it is placed the receptaulum seminis, which is connected with the uterus by a narrow assage. The receptaculum seminis is a small pocket which is filled

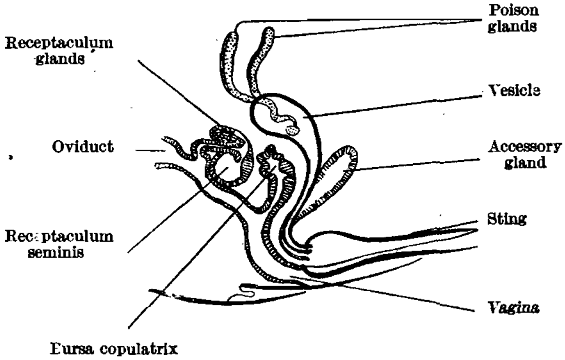

Fig. 39. Reproductive organs of *Myrmica rubra* ♀. (Janet.)

with the male element during copulation. A pair of glands are situated at the apex of this receptacle; these secrete a nutritive fluid, which keeps alive for many years the male element, or sperm. The eggs are fertilized during their passage through the uterus by

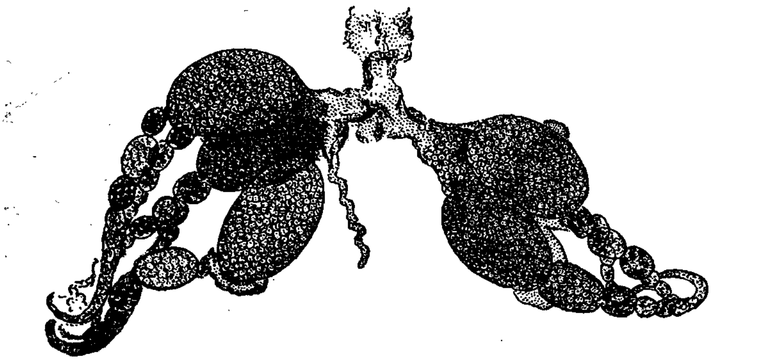

Fig. 40. Ovaries of pseudogyne of *Formica rufa.*

sperm ejected from the receptaculum. The ovaries consist of a number of tubes, the *ovarioles,* each tapering towards its apex, and in these the eggs are formed. The ovarioles are attached at their narrow ends to the pericardium, which lies immediately under the basal tergite of the gaster.

The number of ovarioles in each ovary varies considerably in

different species—in the female of *Anergates atratulus* they consist of 12, *Myrmica laevinodis* 12, *M. ruginodis* 8, *M. scabrinodis* 8–9, *M. sulcinodis* 9–11, *Acanthomyops niger* 30–40, *A. flavus* 24, *Formica rufa* 45, and *F. rufibarbis* 18–20, etc.

The ovaries are present in the worker also, the number of ovarioles, however, being considerably reduced. It has been estimated for each ovary in *Myrmica laevinodis, ruginodis* and *scabrinodis* as 1, *Tapinoma erraticum* 1, *Acanthomyops fuliginosus* 1–2, *A. flavus* 1, *Formica rufa* 4–10, *F. pratensis* 2–6, *F. sanguinea* 3–6, etc.

The receptaculum seminis is usually wanting in the worker, though it has been found present in individual specimens of many species. Copulation between males and workers has not been observed, though the former may sometimes be seen to endeavour to embrace the latter. Eggs laid by workers in captivity have frequently been observed to produce males, and indeed it was formerly supposed that only males were developed from such eggs, but more recently

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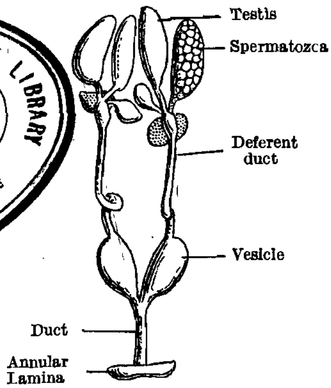


Fig. 41. Reproductive organs of *Myrmica rubra* ♂. (Janet.)

a number of well-authenticated cases have been recorded in which workers have developed from eggs laid by the latter.

The reproductive organs in the male ant consist of the *testes, vasa deferentia, seminal vesicles,* and *ejaculatory duct.* Each testis is formed of a number of bodies which are found in a similar position in the gaster to that of the ovaries of the female, and are filled with spermatozoa. The number of bodies to each testis varies in different species—in *Anergates atratulus* there are 3, *Myrmica* species 4, *Formica sanguinea* 21, etc. The vasa deferentia, or deferent ducts, are long tubes which proceed from the bodies of the testes, and at their posterior ends are enlarged to form a pair of sacs, the seminal vesicles. These are united to form a narrow ejaculatory duct, which has its opening at the base of the penis.

The Circulatory, Respiratory, Muscular and Nervous Systems

re beyond the scope of this work, and can only be very briefly iscussed. For further details the reader is referred to the works f Berlese, Child, Dujardin, Forel, Hicks, Janet, Johnston, Lubock, Nassonow, Rabal-Ruckard, Wheeler, etc. etc.

The Circulatory System.—The blood, a colourless liquid, is circuιted through the body by the contraction and dilatation of the eart, which consists of a tube situated in the mid-dorsal region of he gaster.

The Respiratory System.—The air is distributed through the ystem by *tracheae* or air tubes; these open at the *stigmata* or *piracles*. Ten pairs of spiracles are present, eight of which occur n the eight basal abdominal segments, and, as we have seen, a

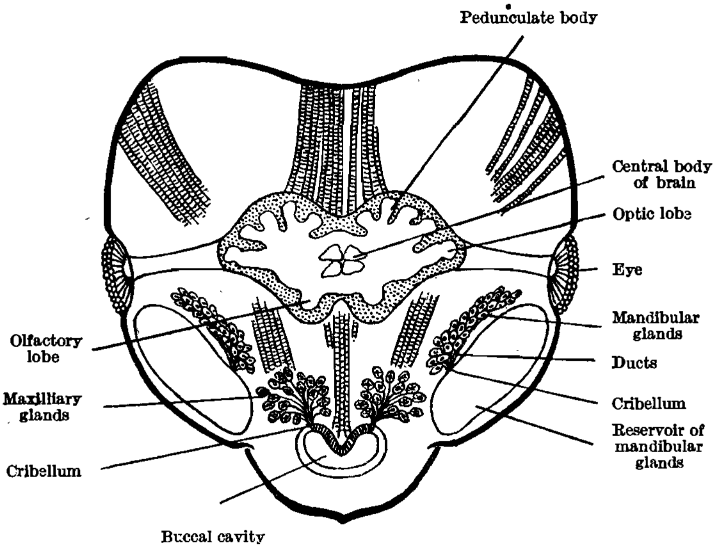


Fig. 42. Brain, etc., of *Acanthomyops fuliginosus* ☿. (Crawley.)

pair each on the meso- and metathorax. Janet has described and figured elaborate valves with which the stigmatic orifices are furnished.

The Muscular System.—The only point that concerns us here is the interesting fact, demonstrated by Janet, that the wing-muscles in queen ants after the marriage-flight become degenerated through histolysis. The fatty and albuminoid substances thus derived are carried to the abdomen in the blood, where they are taken up by the ovaries and assist the growth of the eggs. When the greater part of the wing-muscles has disappeared the thoracic tracheae become considerably enlarged, in consequence of which old queens will float when placed in water, etc.

The Nervous System.—Ganglia occur in the head, pro-, meso-, and metathorax, and abdomen. These are connected by two longitudinal cords, and nerves run from the ganglia to the various organs. The ganglion above the oesophagus is considered to be the brain. The frontal lobes of an ant's brain, which have been compared with the cerebrum of vertebrates, contain two pairs of pedunculate, or mushroom bodies, the *corpora pedunculata.* The olfactory lobes, which have been compared with those of the vertebrates, contain a large number of round bodies, the *glomeruli.* The pedunculate bodies are often largest in the worker and least developed in the male, and this has been supposed to show that the former was the most, and the latter the least, intelligent of the three sexes. Wheeler, however, has shown that the pedunculate bodies may be as highly developed in the female as in the worker, and by no means vestigial in the male, and in any case it is very doubtful if the female is less intelligent than the worker.

Many sense organs—tactile, olfactory, and gustatory sensillae, chordotonal organs (first discovered by Lubbock in the fore tibiae and subsequently by Janet in other parts of the body, and supposed to be auditory in function), Johnstonian organs, etc.—have been carefully studied and described, but they are far too complicated to be treated within the limits of this work.

LIFE HISTORY.

Propagation.—The mating of the male and female ant is known as the marriage-flight, and is one of the chief events in the lives of these insects. The time of the year, as well as the time of the day, in which it occurs, varies considerably with the different species. Among our British ants the nuptial flight may take place, according to the species, at any date from May to October, and at any hour from very early morning to midnight.

These flights often occur at many points in a large area on the same date, and a number of different species are affected at the same time. The workers are much excited; they direct the operation, preventing the males and females from leaving the nest until the appointed time, and it is evident that meteorological conditions influence them in this matter.

When both the male and female are winged they fly off into the air, and with those species in which the former is considerably smaller than the latter, copulation takes place on the wing. When, however, the sexes are of the same size, they either join in the air and fall to the ground, or the male seeks the female on the ground, on trees, bushes, etc., or even in, or on, the nest. When one of the sexes is wingless (no ants are known in which both male and female are wingless, and in Britain no species occurs in which the

female is apterous) a "marriage-flight" in the strict sense of the word cannot of course take place, but a similar period of excitement is present, and copulation between brother and sister (adelphogamy) in or on the nest, is the rule.

I have, as far as possible, given under each of our species an account of the method of and time for the marriage-flight and the appearance of the winged sexes, etc.

After the marriage-flight the males do not necessarily die at once, as they can be kept alive for months afterwards in observation-nests; nor are they injured when separating from the female, but they wander aimlessly about, without ever returning to their nests, and most of them are probably eaten by birds, or killed by strange ants and other insects.

Many females also share the same fate, but those which escape endeavour to found new colonies—this is brought about in various ways.

Colony Founding.—It is only within comparatively recent years that it has been possible to give anything like a complete and connected account of the origin of the ant colony. For more than a century this question has occupied the attention of many observers, who, though expressing widely divergent views, have helped by their patient investigation to accumulate evidence without which the present state of knowledge on the subject could not have been reached.

As far back as 1747 William Gould actually made an experiment on fertile female ants. In his own quaint language he says: "Upon frequent opening of Mole-Hills, amongst them I met with three, in each of which was a Cluster of large Female Ants, amounting to six or seven in a Cluster. They lay near the Surface, but had no regular Apartment. . . . Upon Dissection several of them had Parcels of Eggs in their Insides. I deposited one of the Clusters in a Box with some Earth, under which they concealed themselves, and united together, but did not work any Lodgment. Some Time after, three or four of these Females laid a few Eggs, but did not seem to take any great notice of them. For Curiosity I placed in the Box, a Cell of Workers of the same Species, and it was surprizing to observe what Fondness was expressed. The Common Ants immediately surrounded the Females, took care of the Eggs, and in a short Period made an Apartment in the Earth fit to receive them. It may also be observed that there were no Common Ants in the Hills where I found the above Clusters."

The above is valuable, not only as showing that fertile females were received by strange workers of their own species, but also because it is the first recorded instance of a number of females after the marriage-flight voluntarily associating together and laying eggs.

P. Huber (1810) carried experiments on fertile females a stage

further. He enclosed several fertilized females in a jar full of damp earth, in which they excavated cells. They laid eggs and brought up several fair-sized larvae, which, however, perished owing to his own neglect.

The first who actually demonstrated that females, after the marriage-flight, are capable of bringing up their brood to maturity unassisted, was Lord Avebury, in 1876, whose experiment is referred to under *Myrmica ruginodis*.

It was subsequently assumed that all species of ants founded their colonies in this way. Modern researches, however, have shown that though this is true for the large majority of ants, many species employ very different methods.

Some writers have proposed elaborate classifications of all the different methods of founding a colony, but space does not permit me to discuss them here.

The following table, taken from a paper on the founding of colonies by queen ants, read at the Entomological Congress at Oxford, by Crawley and myself, briefly shows all the known methods in which a colony may arise :—

I. (*a*) The female ant, after the marriage-flight, removes her wings, seeks a suitable situation, constructs a cell, and brings up her colony alone.
(*b*) Several such females may voluntarily associate and found a colony in a similar manner.

II. The female seeks a nest of another species of ant, is adopted willingly or otherwise by the workers, who bring up her brood. In some manner the host-queen, if present, is eliminated. Then either (*a*) in course of time the host colony dies out, and a pure colony of the female's species remains ; or (*b*) the mixed character of the colony is kept up by means of slave-raids on nests of the host species by the female's offspring.

III. The female is adopted into a colony of another species and lives side by side with the rightful queen. The intruder's offspring of all sexes, but only workers of the host species, are reared together in the nest.

IV. Differs from II (*a*) only by the fact that, the species of the alien queen having no worker caste, the colony only lasts for the lifetime of the host workers.

Group I may be considered to represent the normal method, and Groups II, III, and IV the abnormal methods.

In both I and II after the colony has become established, young females reared there may be received back into it, or may enter another colony of their own species after the marriage-flight. The fertilized female removes her wings by working them

backwards and forwards, pulling them with her legs and mandibles, or rubbing them against twigs, grass-stalks, or anything handy. In some cases young females which have been fertilized on, or near, their own nest, will be brought back by the workers, who help them to remove the wings.

The shedding of the wings by a fertile female alters her instincts, causing her to become more timid, and to shun the light. Indeed Wheeler has shown that, with some species, the artificial deälation of a virgin female has the same effect upon her as the loss of the wings to a fertile one.

It is a remarkable fact that an old queen will, if removed from her nest, again carry out all the labours necessary for the starting of a new colony; although she may have lived an uneventful life for years, being fed and cleaned by her workers, and doing little except lay eggs. Thus an old female belonging to Group I, will under these circumstances excavate a new cell, lay eggs, and bring up a fresh brood; and one belonging to Group II, if introduced into a nest of the host species, will act in the same manner as a young fertile female.

I shall describe, at some length, under each species the colony founding of all the British ants.

Metamorphosis.—The female ant when laying lowers her head and raises her gaster; shortly an egg appears, which is quickly extruded, but remains for some time at the tip of the abdomen until she deposits it on the ground. The workers at once pick up the eggs and collect them in a heap, sometimes even they remove them from the body of the female, drawing them out as they appear. They constantly lick and caress with their antennae the queen's gaster when she is laying. In some cases the queens lay eggs on the march and these are at once picked up by the workers.

Young queens (and also workers which lay) will remove their own eggs, bending the gaster forward between their legs, and pulling out the ovum with their mandibles.

The eggs of ants are quite small, even those of the largest species, in proportion to their size. They are white, or yellow in colour, varying in shape in different species, being round, elliptical, or elongate, and consist of a delicate shell or chorion enclosing a thin liquid yolk.

Ant's eggs are said to grow after they have been laid; this has not been proved by measurements, but from observations in artificial nests it appears to be the case; moreover, the ants are constantly licking them and covering them with a coating of saliva, which probably assists in this process.

This salivary coating causes the eggs to adhere together in larger, or smaller, packets, which enables them to be more easily carried about. The coating probably also contains some antiseptic

properties against fungoid growths—I have noticed in observation-nests that neglected eggs have quickly gone mouldy.

The workers and young queens, and in some cases the old queens as well, continually move and carry about the egg-packets. Many species arrange the eggs, larvae and pupae in groups according to their age and condition, as the different stages require different degrees of moisture and temperature.

Eggs are laid by the young females of some species almost immediately after fertilization, whereas with others oviposition does not take place until the year after the marriage-flight. The time required for the eggs to mature varies very much both in different species, and also under different conditions. It may only occupy a few days, or it may require six weeks ; and unfertilized eggs take much longer to hatch than fertile ones. A large proportion of the eggs laid are eaten by the ants themselves, chiefly by the workers, though also by the queens, both in new and in long-established colonies.

A young queen eats some of her own eggs, and also feeds her first brood with them.

A large number of the eggs laid by workers in queenless nests are always devoured, and a worker will eat her own egg as soon as she has laid it.

Parthenogenesis.—It was supposed that Dzierzon's theory for the honey-bee, that unfertilized eggs only develop into males, applied to ants also, but although Lord Avebury, Janet, Forel, Miss Fielde and others have shown that this is frequently the case, more recently Tanner, Reichenbach, Mrs. Comstock, Crawley, and myself have proved that unfertilized eggs laid by workers can develop into workers.

Indeed, under certain circumstances—such as the adoption of a *Acanthomyops umbratus*, or *A. mixtus* female into a nest of *A. niger* or *A. alienus*—workers only seem to be developed from worker eggs.

Crawley and I have also observed eggs laid by virgin females, but on these occasions, when the eggs have developed, only males were produced.

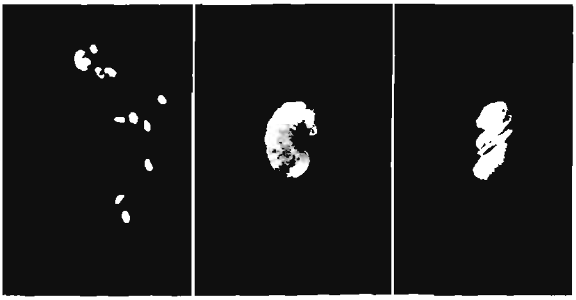
The particulars of these different experiments—when they concern ants that occur in Britain—will be found under the species in question.

Larvae.—The larvae of ants belong to the vermiform type, being without legs, or any trace of eyes. They are helpless white or yellowish grubs, entirely dependent on the queens and workers, and are usually pear-shaped, or sack-like, being broadest posteriorly, but in a few cases they are cylindrical, or barrel-shaped, i.e. broadest in the middle.

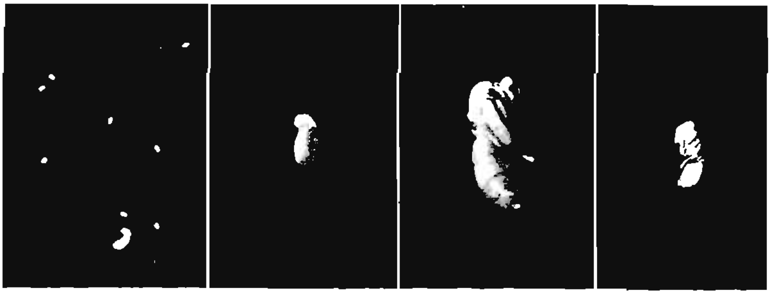
The head is small, but distinct ; the neck is narrow and often bent downwards over the ventral surface, considerably more so in some species than in others.

PLATE I.

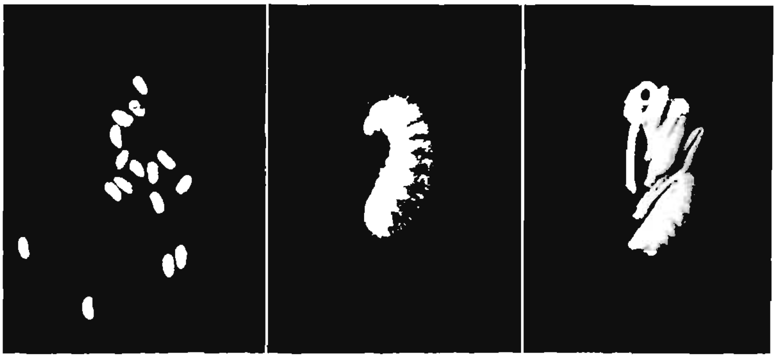
Eggs of *Ponera coarctata*.



Eggs and small larva, full grown larva, and pupa of *Myrmecina graminicola*.



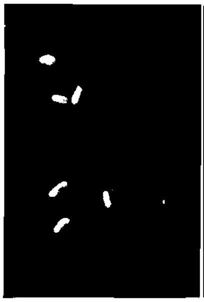
Eggs and small larva, larva, and male and worker pupa of *Solenopsis fugax*.



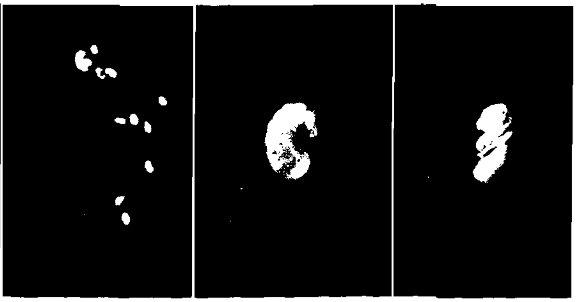
Eggs, larva, and pupa of *Myrmica ruginodis*.

Face page 30

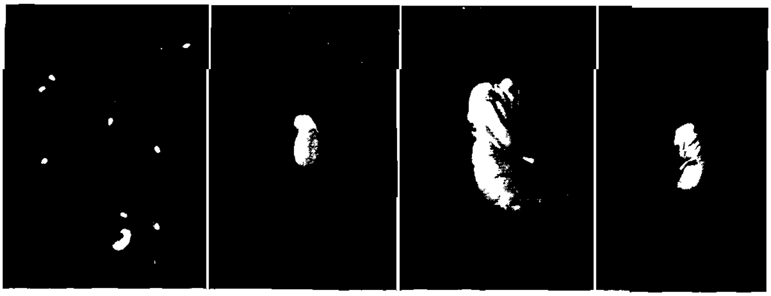
PLATE I.



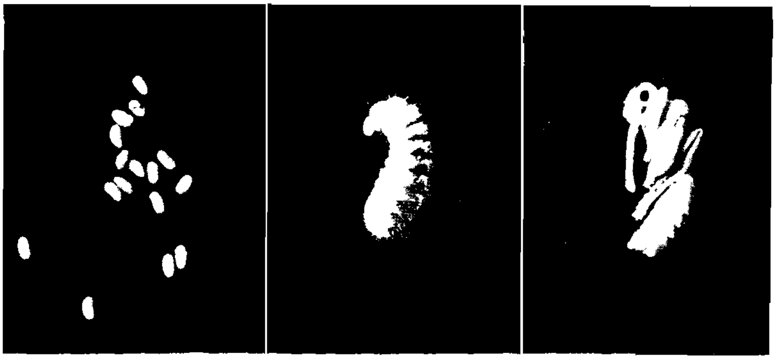
Eggs of *Ponera coarctata.*



Eggs and small larva, full grown larva, and pupa of *Myrmecina graminicola.*



Eggs and small larva, larva, and male and worker pupa of *Solenopsis fugax.*



Eggs, larva, and pupa of *Myrmica ruginodis.*

The body, exclusive of the head, usually consists of thirteen segments, three belonging to the thorax and ten to the abdomen; the segmentation being well marked in some species, but considerably less so in others, especially towards the posterior end.

Ten pairs of tracheal openings are present, a pair each to the meso- and metathorax, and the remaining pairs to the eight anterior abdominal segments.

The mouth parts are not as a rule strongly developed; they consist of a pair of mandibles, a pair of maxillae, and a labium, and usually only the mandibles are more strongly chitinized. The maxillae are furnished on their outer sides with a short, blunt chitinous tooth, as is also the labium, and on the latter two ring-like spots may be seen in some species, being the larval structure which will become the labial palpi of the imago. Although these rings are figured by various writers on ant-larvae, I have not seen any mention of them or suggestion as to their nature. The

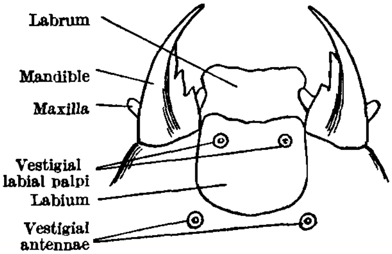


Fig. 43. Head of larva of *Myrmica scabrinodis.*

spinning glands open on the tip of the labium, and are present as well in those species whose larvae do not spin cocoons as in those which do.

The antennae are nearly always wanting in ant-larvae, but Emery has pointed out that in certain exotic species vestigial antennae are present. I have observed certain rings on the heads (similar to those on the labium before mentioned) of *Myrmica* larvae, which are situated in exactly the same position as the rudimentary antennae discovered by Emery in other genera, and these rings no doubt represent antennae of a still more vestigial character.

The larvae of ants are very seldom naked, being furnished with hairs of various kinds, spines, tubercles, etc.

The hairs may be long, or short, simple, serrate, bifurcate, or trifurcate, branched, hooked, or anchor-tipped, etc., and several kinds of hairs may occur on the same larva.

The spines, some kinds of tubercles, and perhaps some hairs, serve to protect the larva against the attacks of its fellows—a hungry larva will sometimes devour another—and also may prevent

its body from coming in too close contact with the damp ground. The longer hairs which terminate with a single or double hook (anchor-tipped in the latter case) are used in hanging the larvae on to the walls or roof of their dwelling, and also in causing the younger ones to adhere together in small bundles—some tubercles and probably other hairs also serve for this purpose—so that they can be more quickly moved by the workers.

The long hooked hairs are curved somewhat in the shape of a letter S, so that they act as springs, and prevent the delicate skin of the larva from being injured. Thus should an ant quickly seize a larva to remove it from its anchorage, the spring expands, and allows the hair to become unhooked without too great a jerk.

Huber and F. Smith stated that ant-larvae were more thickly

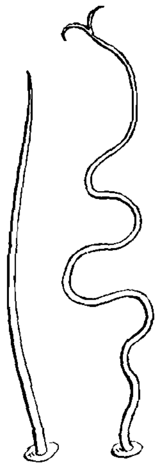


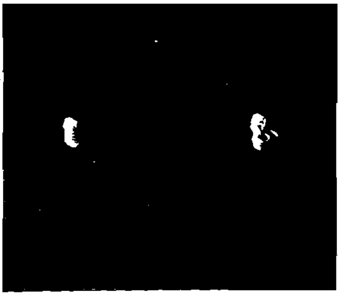
Fig. 44. Hairs on *Myrmica* larva.

clothed with hairs in the winter; this, however, seems very doubtful, and in my observations all young larvae are more hairy than older ones, being equally so in those species which only rear larvae in the summer, as in those which rear them in the winter. With some species larvae are present practically all the year round.

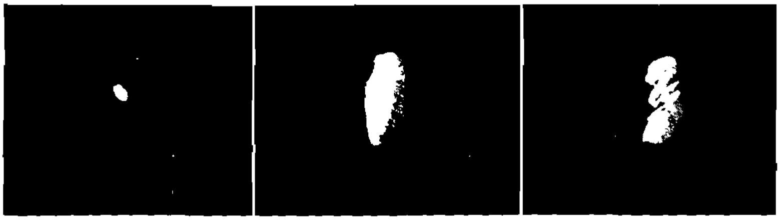
Ants chiefly feed their larvae with liquid food, which is regurgitated into their mouths, but they also supply them with bits of insects, larvae, eggs, etc.; the more solid food being placed by the workers on the bodies of their nurslings or actually held to their mouths that they may feed upon it. Wheeler has recently shown [*Proc. Amer. Phil. Soc.* **57** 292–343 (1918), etc.] that, as in the social wasps, the larvae of ants, either before or after feeding, produce droplets of a sweet salivary secretion, which are eagerly

PLATE II.

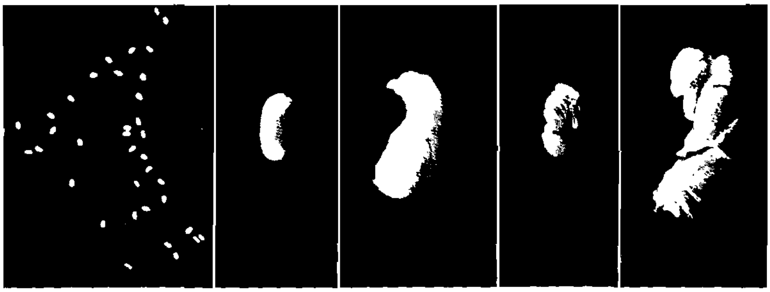
Pupa and larva of *Anergates atratulus*.



Larva and pupa of *Monomorium pharaonis*.



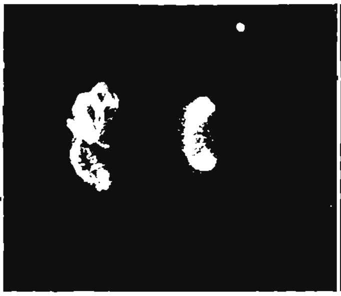
Egg, larva, and pupa of *Leptothorax interruptus*.



Eggs, small and large larva, worker and male pupa of *Tetramorium caespitum*.

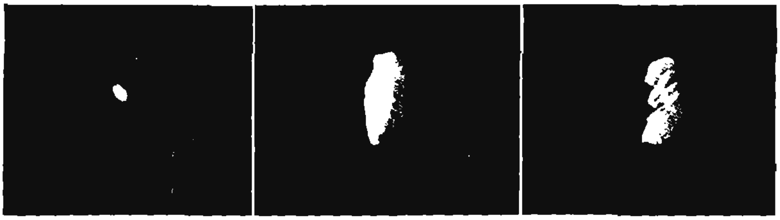
Face page 32.

PLATE II.

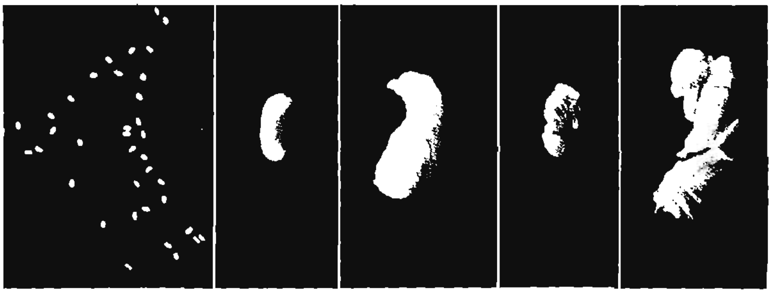


Pupa and larva of *Anergates atratulus*.

Larva and pupa of *Monomorium pharaonis*.



Egg, larva, and pupa of *Leptothorax interruptus*.



Eggs, small and large larva, worker and male pupa of *Tetramorium caespitum*.

Face page 32.

imbibed by the adult ants, and this interchange of food between adult and larva he designated as trophallaxis. Great attention is paid by the nurses to their charges, as they not only feed them, but also continually clean and lick them, and carry them about. The length of time occupied in the larval state varies considerably, both with species and individuals ; it may last for only a few weeks, or for many months, or even for over three years, but this extreme length of time is probably due to extraordinary circumstances.

Larvae which hatch from parthenogenetic eggs, take longer to develop than do those from fertile ones.

Pupae.—Ant pupae are either naked, or enclosed in a cocoon, the latter being invariably present in the *Ponerinae,* often in the *Formicinae,* but not in the *Myrmicinae* and *Dolichoderinae.* The fact that the pupae of the most primitive group always possess cocoons suggests that this habit is an inheritance from solitary ancestors. Wheeler has recorded the presence of the naked pupa of a Dolichoderine ant in Baltic amber, which shows that the absence of a cocoon in this subfamily is not a recent development. In a few genera of the *Formicinae* there is no cocoon, but even with those in which one is usually present naked pupae may often be found, even in nests which also contain pupae in cocoons. It is very difficult to understand this, or to see what, under these circumstances, can be the object of a cocoon at all.

Forel says he has found these naked pupae only in the late autumn, a cocoon always being present with the summer larvae. In England, however, I have found naked pupae of *Acanthomyops* and *Formica* species in their nests in June, July, August, and September.

When a larva is fully grown it becomes straight and rigid, the legs, wings, etc., which are visible beneath its skin, are packed closely to the body, and it is now a semipupa. The larval skin then splits down the back, and is pushed off posteriorly.

Those larvae which do not remain naked after pupation naturally spin their cocoon before the semipupal stage is reached. When they are ready to spin, the workers cover them over with little bits of earth, sand, etc., or bury them in shallow holes, to provide them with starting-points on which to commence spinning.

The workers dig up the cocoons when completed, render them clean and smooth by removing all adhering substances, and pile them in a heap.

In observation-nests where no earth or sand is present I have noticed that the workers will make use of bits of plaster, cotton-wool, or anything handy, with which to cover a larva when ready to spin.

The colour and texture of the cocoon varies in different species, being white, yellow, buff, or dark brown, and finely or coarsely sculptured, etc.

A black spot is usually to be seen at the posterior end of the cocoon, which consists of the larval excreta, and the larval skin is also present; but with naked pupae these are removed during pupation by the workers.

The workers help the young imago to emerge—the latter before it has acquired the mature coloration has been called a "callow"—by biting a hole in the cocoon, and drawing out the ant. Sometimes the workers remove the pupae from their cocoons before they have reached the imago stage.

It was formerly supposed that an ant was unable to get out of its cocoon without assistance, and if left would perish, but this is not always the case.

The pupal skin, which closely covers the body and limbs, and which, of course, is the only covering of naked pupae, is also carefully stripped off by the workers, though ants may free themselves from it. If it is not thoroughly removed it may produce cripples, especially in the winged sexes. I have frequently saved young callows which had not been properly attended to by their mother, or foster-mothers, in my nests, by carefully removing the remains of the pupal-skin with a wet paint-brush.

The duration of the pupal period is shorter than that of the larval one, and may occupy two or three weeks.

The pupae are kept in drier parts of the nest than are the eggs or larvae, and some species of ants build special incubators of earth, or vegetable detritus, etc., to accelerate their development. Ants kept in plaster-nests in a warm room will pile up their pupae in the chamber nearest to the fire, and watch over them for some time—it is very amusing to observe a worker suddenly seize a pupa and hurry off with it, as fast as she can, back to the cooler chambers, as if it was a joint before the fire, and was just cooked to a turn.

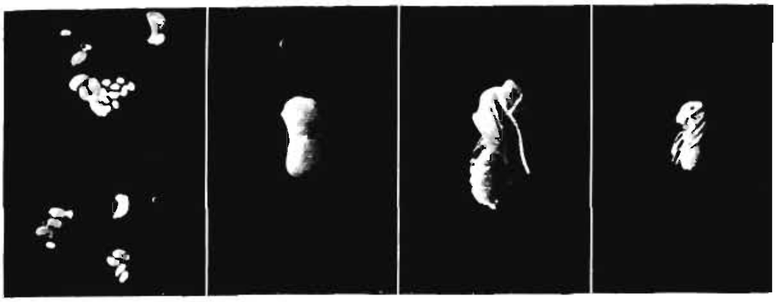
Temperature undoubtedly influences both the period for egg-laying and the time required for development of the brood.

In my observation-nests kept in a hot room the queens of some ants, which in nature would not lay before the spring, have commenced to do so as early as December.

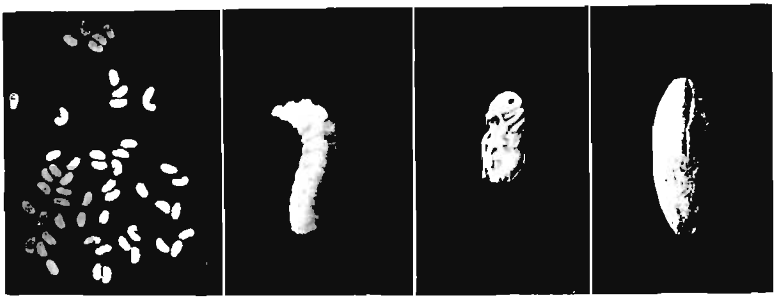
The eggs, larvae, and pupae of all British ants which I have been able to find will be briefly described below under their respective species or genera.

Polymorphism.—Ants vary exceedingly both in habits and structure, it being almost impossible to lay down rules on any points concerning them to which exceptions cannot be found. In the following points—and many others might be mentioned—ants vary, not only in different genera and species, but often in the same species itself: the time for the appearance of the sexes, and for the marriage-flight; whether the males and females are winged or wingless; whether the former are more abundant than the latter, and whether they are both present at the same time, or in the same nest; whether

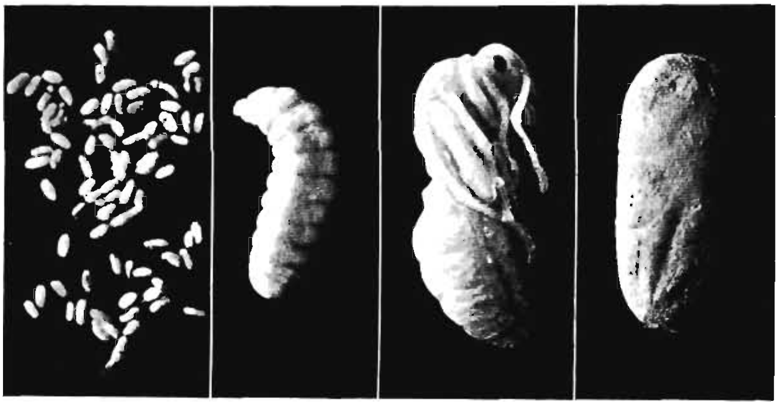
PLATE III.



Eggs and small larvæ, larva, and male and worker pupæ of *Tapinoma erraticum*.



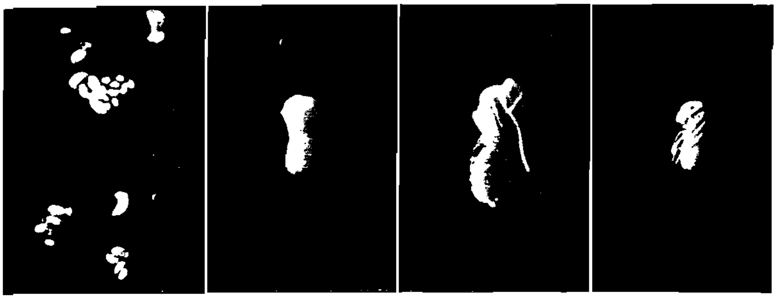
Eggs and small larvæ, larva, naked pupa, and cocoon of *Acanthomyops niger*.



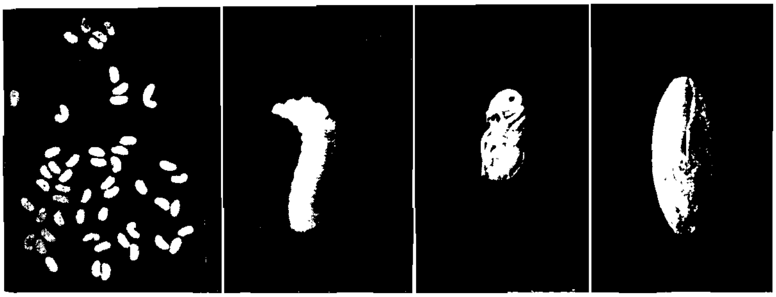
Eggs, larva, naked pupa, and cocoon of *Formica rufa*.

Face p.

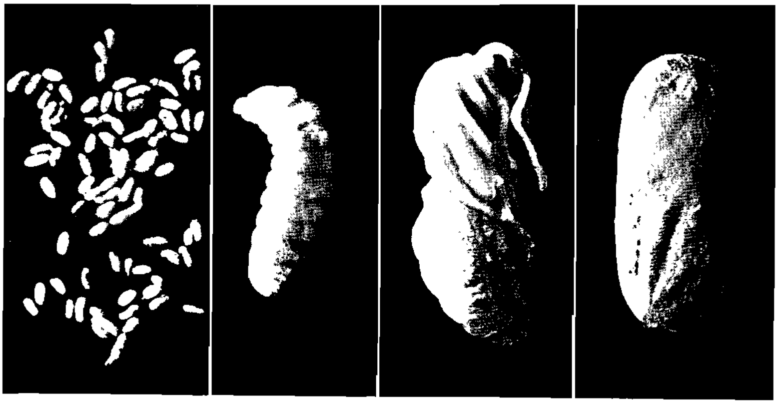
Plate III.



Eggs and small larvæ, larva, and male and worker pupæ of *Tapinoma erraticum*.



Eggs and small larvæ, larva, naked pupa, and cocoon of *Acanthomyops niger*.

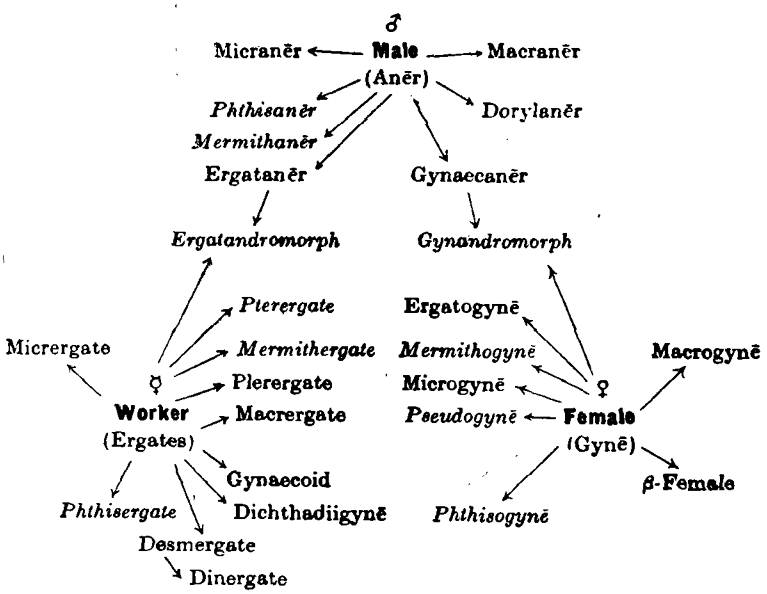


Eggs, larva, naked pupa, and cocoon of *Formica rufa*.

the ocelli are present or absent in the wingless forms (worker, male or female); whether the larvae occur in the summer or winter or both; whether the pupae are naked, or enclosed in cocoons; how the colony is founded; in what situations, and under what circumstances the nests will be built, etc. etc.

These variations, however, are not what is understood by polymorphism in ants.

Polymorphism is possessed by those species in which the sexes —one or both of them—occur in two or more forms; these forms being more or less regularly produced in certain generations, or in each successive generation, which are sprung from the *same parents.*



These phenomena are very highly developed in the ants, in most species of which a winged male and female and a wingless worker *are present—in a very few cases only, the worker class is wanting.*

These three normal forms are again split up into further "phases," which, however, are neither as constant, nor as important as the primary ones.

Wheeler has constructed a most valuable table to illustrate the series of different phases known to occur among ants. This table is reproduced here (with a few additions), as although some of the phases have not yet occurred in Britain, and others are peculiar to tropical and non-British ants, the table is of so much interest that it would be a pity not to give it *in toto.*

"The three typical phases are placed at the angles of an isosceles triangle, the excess developments being placed to the right, the defect developments to the left, of a vertical line passing through the middle of the diagram. The arrows indicate the directions of the affinities of the secondary phases and suggest that those on the sides of the triangle are annectant, whereas those which radiate outward from its angles represent the new departures with excess and defect characters."

The typical and atypical phases are printed in Roman type, the pathological phases in italics.

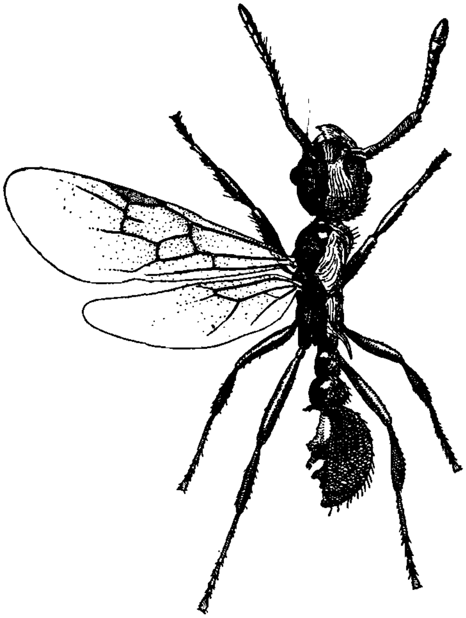


Fig. 45. Ergatandromorph of *Myrmica scabrinodis*. Ditchling, IX. 1909. (Bondroit.)

1. The *male* (*anēr*) is the most fixed of the three primary phases, Typical male ants are always winged, and are often very much alike, superficially, though they may belong to widely separated genera, and even subfamilies, in which the females and workers are very diverse.

The body is usually delicate in form, and the colour is often darker than in the female and worker; though in some cases the male may be yellow, or red, etc., when the female is black. The head is usually smaller and rounder, the eyes and ocelli more highly developed, the mandibles smaller and weaker, and the antennae

2. The *macranēr* is larger in stature than the normal male of the species in question, and is occasionally to be met with in populous colonies.

3. The *micranēr* is smaller in stature than the normal male of the species in question.

4. The *dorylanēr* is a large form of male peculiar to the Doryline ants. This sub-family does not occur in Britain.

5. The *phthisanēr* is a pupal male which in the larval or semi-pupal state has had its juices partially extracted by an *Orasema*

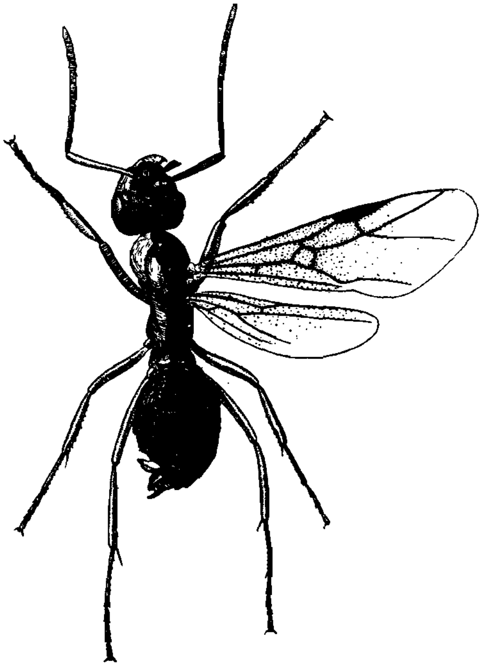


Fig. 46. Ergatandromorph of *Formica sanguinea*. Bewdley, 20. VII. 1909. (Bondroit.)

larva, and is unable to pass on to the imaginal stage. This has not been observed in any British ant, nor have the similar forms which occur in the female and worker.

6. The *mermithanēr* is a male with short wings, caused by the presence of an internal worm of the genus *Mermis*.

7. The *gynaecanēr*, or gynaecomorphic male, resembles the female rather than the male. The number of joints of the antennae is the same as in the former, but it may be winged, or wingless as in *Anergates*.

8. The *ergatanēr*, ergatomorphic, or ergatoid male, is without

3. The *ergatogyne*, ergatomorphic, or ergatoid female is a gless form. It possesses ocelli, the eyes and thorax being more those of the normal female. In some species it is the only form sent, in others in which the female is dimorphic, a winged form occurs. No British species possesses an ergatoid female. hen a wingless female is spoken of, it must be understood that does not refer to the deälated female—i.e. one who has removed ost her wings after the marriage-flight—but to an apterous form ch has been born without wings, and whose thorax shows no e of wing-insertion.)

4. The *β-female* is an aberrant form, occurring either with or hout the normal female, and characterized by excessive development in the legs, and in the pilosity of the body. This form has not n observed in Britain.

5. The *mermithogyne* is a female with short wings due to the sence of an internal worm of the genus *Mermis*.

6. The *microgyne* is an unusually small female; it may be sent in the same nest with normal females, and with some

Fig. 48. Pseudogyne of *Formica sanguinea*. Woking, 21. V. 1913. (Bondroit.)

species it is the only existing form of this sex. In either case it may be even smaller than the largest workers.

17. The *pseudogyne* is a wingless deformed-looking individual, combining the thoracic characters of the female, with the size and gaster of the worker. The characters of these forms vary greatly, no two specimens out of a considerable number being exactly alike. The colour is often much lighter than in the normal female; the number of the ovarioles is much reduced, being sometimes less even than in the normal worker; and macro- and micro-pseudogynes occur.

They have been said to be useless and cowardly ants, but I have found that they will work, bite, spray acid, clean each other, and tend the brood, as do the normal workers.

Wasmann considers that they are brought about—in *Formica* colonies—by the presence of beetles of the genera *Lomechusa* and *Atemeles*, and Wheeler has suggested that they arise from starved female larvae. From my own experience with pseudogynes I do not consider that either of these hypotheses will always, or alone, account for their presence in a colony; as though both these stimuli may induce this state of things under certain circumstances,

under others, some other cause, about which we know nothing at present, may produce the same result.

18. The *phthisogyne* arises from a female larva under the same conditions as the phthisaner.

19. The *worker* (*ergates*) is an imperfectly developed female, wingless, and possessing a more simply constructed thorax. The ocelli, which when present are smaller than in the female, are often wanting; the eyes and gaster are small, and the mandibles, antennae and legs are well developed. The largest and smallest workers, in many species, are connected by a series of intermediate forms. With species in which the worker is dimorphic, the intermediate forms have disappeared, and, further, where only a very

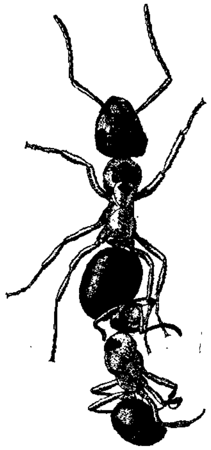


Fig. 49. Pseudogyne of *Formica rufa* var. *rufo-pratensis* fastened to the leg of a worker. Nethy Bridge, V. 1912. This proves pseudogynes will fight and bite. (Bondroit.)

small worker is always present, the large worker has also been eliminated.

20. The *pterergate* is a worker with vestiges of wings, the thorax being either that of the normal worker, or somewhat approaching that of the female.

21. The *mermithergate* is a somewhat enlarged worker, due to the presence of an internal worm of the genus *Mermis*. The presence of the parasite in the worker appears to produce excess, instead of defective characters as in the male and female. Thus small ocelli and a tendency towards the female thorax may result from it. This phase has not been discovered in any British worker-ant.

22. The *plerergate*, replete, or rotund, is a worker which in its

callow stage has acquired the habit of distending the gaster with liquid food. The well-known "honey ants" are the best examples, and no such form occurs in Britain.

23. The *macrergate* is larger in stature than the normal worker of the species in question, and is usually present in populous colonies.

24. The *micrergate* is a worker of unusually small size. It is often present in nests which contain macrergates, as well as in moderate colonies. The first brood of a young queen usually consists of this form.

25. The *gynaecoid* is an egg-laying worker. In some families the queen has disappeared and has been replaced by this form of

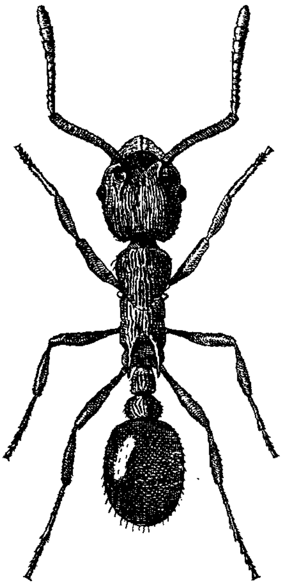


Fig. 50. Pterergate of *Myrmica scabrinodis*. Yelverton, VIII. 1913. (Bondroit.)

worker. Should a colony lose its queen, one or more workers may become substitute queens, lay eggs, and be treated accordingly by the other workers. I have found such workers in nests of *Formica rufibarbis*, *F. fusca v. rubescens*, species of *Leptothorax*, etc.

26. The *phthisergate* corresponds to the phthisaner and phthisogyne, and arises from the same causes.

27. The *dichthadiigyne*, or dichthadiiform female, is peculiar to the *Dorylinae*, and, of course, is not found in Britain. It is without

eyes, ocelli, or wings, and is probably a further development of the gynaecoid worker.

28. The *desmergate* is an intermediate form between the soldier and the typical worker. Wheeler suggests that the term might also be employed to designate the intermediate forms between the small and large workers in such genera as *Monomorium*, *Formica*, etc. This does not seem to be a very satisfactory definition, as all the workers in a colony, intermediate between the macrergate and the micrergate, would be called desmergates.

29. The *dinergate*, or soldier (which is indicated by the symbol for Jupiter—" ♃ ", to distinguish it from the worker, for which that of Mercury—" ☿ " is used), is a macrergate with a greatly developed head. The jaws are often very large, long, or massive, and the thorax sometimes approaches that of the female in structure. The name " soldier " is not very happily chosen for these forms, as they by no means only fight and guard the nest, but also perform other special functions, in different species, such as crushing seeds, using their heads to act as " front-doors," etc. They do not occur in any British genera.

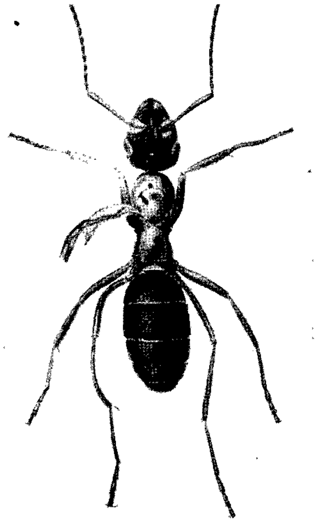
Polymorphism is so vast and complicated a subject, and so many different opinions have been offered to explain the origin of its various phenomena, that it can only be further discussed very briefly in this work. Anyone who is anxious to study the subject more deeply will find the whole matter thoroughly dealt with by Emery, Escherich, and Wheeler.

The chief problem of polymorphism is to account for the various worker forms, and those such as the soldier, pseudogyne and ergatogyne, etc., which are intermediate between the worker and the female.

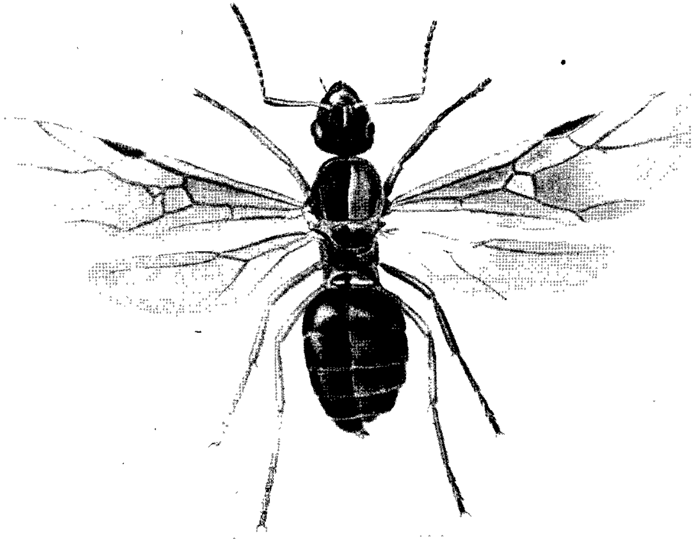
Weismann believes that the various castes are represented in the egg by corresponding units, fertilization being the stimulus which calls the female determinants into activity, and meagre feeding the stimulus which arouses the worker-producing determinants in the young larva from fertilized eggs.

Herbert Spencer thought that the female castes were not predetermined, but that they were brought about by differences in the feeding. Neither of these opinions offers an adequate explanation; it is certain, however, that both qualitative and quantitative feeding do exercise considerable influence in the matter.

It was formerly supposed that " queen " ants are not reared in captivity, the only exception being recorded by the late Lord Avebury. He mentions that the nest in question had been richly supplied with animal food, which he says may possibly account for the fact. I have, however, reared winged females in my observation-nest of *Myrmecina graminicola* nearly every year since 1915 (as will be seen when we come to the account given of that ant). In 1922 many more winged females and far fewer males were reared



Ergatandromorph of *Formica rufibarbis*.
Weybridge, 29. VII.13.



Gynandromorph of *Formica sanguinea*. Bewdley Forest, 21.VII.09.

(From paintings by Bondroit.)

Face page 42

than in any single year previously, and the colony was given less food in the winter before than usual. It is very difficult to draw any safe conclusions from the above as to the reasons for the production of females (i.e. ♀♀ *not* ☿☿) at any time in a colony. The late Professor Emery expressed the views that females are only produced from larvae which have been fed with liquid food disgorged into their mouths by the ants, and not by bits of insects and other animal food given to them. Also, that perhaps the most important reason why they are produced is when there is no queen in a nest. If I had not read his papers, I should have come to the conclusion that in 1922 females were produced in my colony by an abundance of animal food (raw beef, etc.) fed to the larvae, after a winter of scarcity. Also, in this colony there can never have been the impulse to bring up females through their absence, as the original queen, the queen-mother of the colony, was present in 1915 when winged females were first produced, and ever since then the colony has consisted of nearly as many females as workers. In 1925 *no females were reared, and I account for this by the fact* that in the winter of 1924–25 the ants were not fed at all, and were kept in a cold room, the nest only being watered occasionally. Forel considers that the sex of an ant is already determined in the egg—as is the case with Termites.

The following appear to be the stages in the phylogeny of ants :—

1. A pre-social stage with a single kind of male and female.
2. A social stage with a single kind of male and female, but the nesting and nursing instincts have developed.
3. A social stage with one kind of male, and two or more kinds of female, all fertile, but those that build and hunt for food are becoming less fertile.
4. The present stage with usually one kind of male, a fertile form of female, and one or more so-called "sterile" females, or workers. These workers, however, are fertile with sufficient frequency to maintain (principally through the male) a representation of their characters in the germ-plasm of the species.

Emery believed that a worker-like wingless form was the oldest type of female, both because the females in the *Mutillidae* are wingless, and because in the *Ponerinae*, the most primitive subfamily of ants, wingless females are more frequent than in the higher subfamilies. As Escherich points out, however, it is unlikely that a wingless form which had once acquired wings, would again lose them, as in the case of wingless females.

Weismann considered the egg-laying of the workers as too infrequent to influence the germ-plasm of the species. It is not, however, so infrequent as he supposed, and as we have seen under

Parthenogenesis, not only males but workers also are produced from these eggs ; so there is no reason why the transmission of characters acquired by this caste should be either impossible or improbable.

PYSCHOLOGY.

Ants possess the senses of Smell, Touch, Taste, Sight, and probably Hearing in some form or other.

The sense of smell, which is partly combined with that of touc is of the first importance to these insects, and undoubtedly reside in the antennae. Ants are quickly attracted by some odours an repelled by others ; they wave their antennae about when a odorous substance is brought near to them, this being also th case with quite blind species. When tapping anything with th antennae they probably obtain a combined sensation whic Forel has called a "contact-odour." Wasmann speaks of th antennae as "touching-noses" ; he says, ants do not know eac other personally, but recognize each other by an intelligen "parole," a recognized form of antennal stroke. Miss Fielde ha carried out a number of experiments to prove that each of th different joints of an ant's antennae has a different function. Fo example, she considers the final joint recognizes the home or nes odour, the penultimate recognizes personal relations, the ante penultimate the path or track, etc. She also concludes that th whole nest aura changes every two or three months. Thoug these experiments are very carefully elaborated, the results ar by no means conclusive ; the subject being far too difficult an intricate to be settled so easily. It is certain, however, that if a ant's antennae be removed it can neither find its food—only feedin if it accidentally stumbles on to it—nor its way, nor recogniz friends from foes, etc.

Ants possess great delicacy of touch—*tactile hairs* and *sensilla* being present all over the body, as well as on the antennae—an this sense is also of great importance to them. Their extrem sensitiveness to light and temperature is probably closely connecte with their sense of touch.

The sense of taste is situated in the tongue and maxillae. Ant show distinct preferences for certain foods, and they quickly detec any unpleasant substance—even if odourless—mixed with thei food. Wheeler considers that taste is evidently the sense in whic these insects approach most closely the higher animals and man.

Sight varies considerably in different species, some being com pletely blind. The exhibition of "mimicry" in certain myrme cophiles and parasitic ants shows that their hosts possess th power to discriminate colours and forms. Lubbock demonstrate that ants can perceive, and avoid, the ultra-violet rays of th

spectrum, and Forel proved that this was through the eyes—he covered these organs with varnish, when the ants were no longer able to distinguish these rays. Moving objects are more readily observed by ants, but Wasmann has shown that certain species can see an object not larger than a finger at rest at a distance of five to ten centimetres ; smaller objects, such as little beetles, cannot be seen at a greater distance than four to five millimetres. I have frequently observed a worker of *Formica rufa* when pursuing a small beetle, will lose sight of it and run blindly by it. Exner's theory that the compound eyes form of an object a single picture which is more distinct the greater the number of facets possessed by these eyes and the more convex they are, seems to be generally accepted. In the case of the ocelli, however, it has been suggested that they enable an ant to see better in the dark, but as they are largest and best developed in the male—who can see a flying female at some distance—this does not seem to be a satisfactory explanation. Hearing has been denied to ants altogether by some authors, and it is probable that they do not hear, in the ordinary sense of the word. The possession of chordotonal organs in the tibiae (similar to those of crickets, etc.), and other parts of the body, and the fact that numerous ants possess well-developed stridulating organs, seems, however, to point to some form of hearing. Lord Avebury could never find that ants seemed to hear any noises of a variety of different kinds with which he tested them, but he considered it probable that they might produce sounds entirely beyond our range of hearing.

I tested my ants in captivity with the whistle known as the Galton-Edelmann. The human range runs up to 40,000 to 50,000 vibrations per second, but tested by the sensitive flame this whistle is seen to give off musical notes far above that limit. I tried my ants in every way with it, up to its highest range, before which no sounds whatever could be heard by me, but the ants never appeared to notice anything at all.

Wheeler writes on stridulation : " Stridulation, at least among the Myrmicinae, Ponerinae and Dorylinae, is an important means of communication, which Bethe has completely ignored and even Forel and other myrmecologists have failed to appreciate. It readily explains the rapid congregation of ants (Myrmicinae) on any particle of food which one of their number may have found, for the excitement of finding food almost invariably causes an ant to stridulate and thus attract other ants in the vicinity. It also explains the rapid spread of a desire to defend the colony when the nest is disturbed."

I have frequently noticed that when fresh honey is placed in the light chamber of a plaster nest, containing a colony of ants in captivity, after one individual has found it, immediately numerous others pour out and the honey becomes completely covered with

feeding ants. Often, it is true, the first ant or two which arrive at the honey return to the nest and appear to tell, and to fetch, others ; but the appearance of such a large number at once seems only explicable as caused by stridulation. Parker and Miss Fielde found that ants reacted to vibrations reaching them through the soil and other solids. They proved that these vibrations were received through the legs, as when the ant's head, gaster, and any one or two pairs of legs had been cut off it still reacted to them. They conclude their experiments by pointing out that : " It is misleading to ascribe or deny hearing to ants ; they are very sensitive to the vibration of solids, not to those of air ; their reactions could be as appropriately described as resulting from touch as from hearing."

Several authors, however, still maintain that ants do perceive aerial vibrations.

Some writers considered ants to be reasonable, intelligent beings, which possess virtues and morals little behind those of mankind ; thus erring as far on the one side as Bethe on the other, who tried to prove that they were purely automatic machines, only performing reflex actions in response to certain stimuli. If the brain of an ant be pierced it remains standing almost as if nailed to the spot ; occasionally a quiver runs through the body, and one of the legs is raised in the air from time to time. If irritated, it endeavours to resist, but as soon as it is left alone, it again falls into its former stupor. It does not try to escape, to return to its nest, or to join its companions. It has lost the instincts of fear and self-preservation and has become simply a reflex machine. This alone will prove the falsity of Bethe's theory.

Forel, Wasmann, and Wheeler express views intermediate between these two extremes. I agree with Wheeler that ants possess both feelings and impulses, as they undoubtedly experience pleasure and pain, fear and anger, affection and aversion, etc.

That certain of their actions are only reflex ones, just as with ourselves (—Wheeler illustrates this very neatly. He says : " Whether a stinging ant or hornet merely exhibits a pure reflex or has a feeling of anger besides, is a nice problem. I have unintentionally sat on nests of *Vespa germanica*, and *Pogonomyrmex barbatus*, and while I have no doubt that I myself acted reflexly under the circumstances, it will take quite an army of physiologists to convince me that these creatures were acting as nothing but reflex machines."—), while others arise from what is called instinct, is evident ; but personally, from observations on ants both in nature and captivity, I am prepared to grant to them something approaching reasoning power. The following facts appear to support this view : many ants live, comparatively speaking, a very long life, during which time they must learn by experience ; they undoubtedly possess memory ; under certain circumstances, especially in observation-nests, they will break away from their

ordinary behaviour, and adapt themselves to new conditions—this plasticity is what Hobhouse defines as "the power of an organism to adapt action to requirement without the guidance of a hereditary method of adjustment," and Wheeler as "action on the basis of individual, i.e. ontogenetic experience, and as such is commonly designated as 'intelligence'"—they become far less wild in captivity, for example, they soon realize that they are going to be fed when a nest is uncovered, and do not endeavour to escape at once; such species as *Myrmecina graminicola*, which when touched usually roll up and feign death, are with difficulty induced to do so after having been kept for some time, etc.; ants play together, run after each other, pretend to fight, and perform exercises; they have also been noted to assist wounded companions.

Darwin, Belt, Romanes and many other authors have related numerous instances in which ants have appeared to exhibit reasoning powers. It is true that some of the examples given, such as ants covering over tar, moisture, or unpleasant substances with earth, or even with their Aphides, etc., to form a bridge as it would appear, are not as conclusive as would be supposed, it being their natural habit to cover up moisture or anything objectionable in their nests.

I have seen workers in my *F. rufa* observation-nest bringing sticks, etc., from their hillock and casting them into the water-trough as if to build a bridge, some individuals having even crossed the water by this means; but it may have only been a similar case to the above.

Ants which are subject to inundations have learnt how to protect their colonies; Livingstone wrote of ants in Africa: "When all the ant-horizon is submerged a foot deep, they manage to exist by ascending to little houses built of black tenacious loam on stalks of grass, and placed higher than the line of inundation." When an ant colony has been washed out of its nest by sudden heavy rain, or floods, the workers have been observed to collect into a ball with the brood, etc., inside, those on the outside occasionally changing places with the inner layers, and in this way float down the stream, until a place of safety is reached.

I once noticed a somewhat parallel case in my observation-nest of *Acanthomyops umbratus*. Having filled the water-trough too full, the superfluous water escaped under the glass cover and inundated the chamber in which the brood and most of the ants were situated. The workers immediately clustered round their larvae, enclosing them completely, and remained in this position under the water until it had all been absorbed by the plaster walls and bottom of the chamber.

As space will not allow us to consider this subject at much greater length, it is best to turn to, and discuss briefly, some of the most striking psychological phenomena exhibited by ants.

How Ants know each other.

Ants in a colony all know each other, but should a strange ant be introduced, it is at once attacked, and killed or driven out. Ants which have been separated for long periods readily recognize each other again; this has been demonstrated by a number of myrmecologists, and I have myself repeatedly found this to be the case with *Formica rufa* and other species. It has been shown by bathing ants with the acid, or blood, of strange species, with alcohol, and even only with water, that they are no longer recognized by their friends, at least for a time—this proves that ants possess a special odour by which they are known. It is not present in quite freshly hatched ants; should, however, some of these be at once removed from their nest, kept until they are quite mature, and then returned, they will immediately be recognized and accepted. This odour, therefore, is produced in the individual itself, and does not come from an outside source.

When two ants meet they usually tap each other with their antennae; should one be a stranger, it is immediately threatened with open jaws by the other.

Bethe washed individual ants with alcohol to remove their own odour, and then bathed them in the blood of other species of ants. When he had bathed a strange ant A in the blood of a species B, and introduced it into the nest of the latter, it was received in a friendly manner. He then bathed an ant from B in the blood of A, replacing it in its own nest, when it was treated as an enemy. Wasmann, however, shows that Bethe did not carry the matter far enough, and that after a time ants so treated were again recognized as friends or foes, just as they would have been if they had never been bathed.

The facts that (1) different species of ants behave in different ways; (2) some species bring up strange pupae as slaves; (3) females which are temporary social parasites, and also other ants, do enter strange nests both of their own and other species, and get accepted; (4) myrmecophilous beetles are accepted into other nests of their own host ant, or even into those of other ants—(Wasmann and I have made numerous experiments on this point, and many examples of the other points just mentioned will be found in this book, under the different species)—all prove that how ants know each other is not a mere chemoreflex, but that memory, experience, education, smell, touch, and sight, all enter into the matter.

How Ants communicate with each other.

Though ants cannot be said to converse in the ordinary sense of the word, they actually do communicate with each other; conveying intelligence, wishes, etc.

This is proved by the rapidity with which a mass of ants will pour out from their nest to assist any of their comrades which have been attacked, and congregate on any food that one of their number has found. Any such news may be conveyed by stridulation (as before mentioned), by tapping each other with their antennae, pulling at each other with their mandibles, butting each other with their heads, saluting (as described by Crawley, p. 186), tapping on the floor of the nest with their gasters (as I observed in *Leptothorax acervorum*, p. 152), etc. Belt also believed ants could communicate the presence of danger, of booty, etc. etc., to a distance by the different intensity or qualities of the odours they gave off.

Some ants when they wish to be fed by their fellows, stroke the side of the head of the ant they are begging from with the front feet, also rapidly tapping them with the antennae.

When one ant wishes another to come to a certain locality, it frequently carries it to the desired spot; it is evident that the other understands what is wanted, as it rolls up and allows itself to be carried.

All authors since and including Huber agree that ants communicate with each other, in great part, by antennal strokes (antennae language). Anyone has only to study the behaviour of ants for himself to be convinced of this.

Wasmann has enumerated a number of different antennal strokes conveying different ideas. These depend chiefly on the nature of the stroke, whether quick or slow, heavy or light, at longer or shorter intervals, on the top or side of the head, or only on the antennae, etc.

Should an ant find something which it desires to carry home to its nest, but which it is unable to move on account of its weight, or for any other reason, it leaves the find, goes to its nest for assistance, and returns with some of its companions. It is of course clear that the finder has conveyed to the others intelligence that something has been found, and that their help is wanted; moreover, although it may be said to be a reflex action when an ant finds food that it should carry it home; this can hardly be said when the ant returns home unladen, to seek for help.

How Ants find their way.

As with nearly every point concerning ants, or their behaviour, it is impossible to generalize as to how they find their way. Bethe fell into this error; he stated ants went to and from their nests in a purely reflex manner, and for his experiments he selected certain species which always follow a trail. He invented a "polarization" theory, and concluded all ants only found their way by odour-contact.

It is true that many ants, such as *Acanthomyops* species, are chiefly guided in this matter by the sense of smell; but others, such as *Formica* species, are more indebted to that of sight. The latter sense is obviously of no use to blind ants, which, however, find their way quite as well as do those which possess eyes.

Many species, when returning home to the nest, always follow the same path by which they left it; others make for home in a direct line, no matter how much they may have wandered about on the journey out.

If an obstacle be placed on a track of *Acanthomyops fuliginosus*, these ants hesitate for a time, all those arriving at this spot clustering together, until one or more crosses it, and the file resumes its march. Should the same experiment be tried with *Formica rufa*, the obstacle is at once crossed, the procession of ants being in no way interfered with—I have observed the similar behaviour of a single "homing" worker of *F. rufibarbis* (p. 323).

If the eyes of an *Acanthomyops* be covered with varnish, it finds its way as before, but if a *Formica* be treated in this manner, it is unable to do so. These facts prove that smell is the predominant feature in some cases, and sight in others.

Memory also helps ants in finding their way—workers of *Polyergus rufescens* hunting for colonies of *Formica fusca* will locate various nests, but it may be days or weeks before the slave-makers will raid any particular one of them. No track of any kind could be left, and memory alone must help them to go direct to this nest (the same procedure is noted for *Formica sanguinea*, p. 290). Again, when an ant finds a suitable place for a new nest at some distance from the old one, returns home, and induces her companions to move to this spot, the ant must remember where the selected spot was; nor can this be said to be a pure reflex action.

Very many authors, including Bonnet, Brun, Cornetz, Miss Fielde, Forel, Huber, Lubbock, Santschi, Turner, Viehmeyer, Wasmann and Wheeler, etc., have written at considerable length on this subject, but it is only possible to touch very briefly on some of their views.

Wasmann has clearly demonstrated that Bethe's polarization theory is inaccurate.

Lubbock, Turner, and Viehmeyer show that ants are partly influenced in finding their way by the rays of light. It is hardly necessary to mention that ants can find their way in the dark, and that some species are nocturnal in their habits.

Cornetz's theory is that ants are endowed with a special sense of what he calls "pure direction," being guided by some mysterious inner impulse. This compels them to move on continuously, up or down, round and round, right or left, and keep on doing so whatever happens, while the impulse lasts. If it is transported elsewhere, no matter, it still moves on as before. He thinks the human mind

in only conceive of direction as being aimed towards some particuir point of space, but the ant's conception of space may be)mething quite different, and this may account for its behaviour eing sometimes unintelligible to us. Santschi has recently made number of new experiments; his main points seem to be iese :—

1. Cornetz's "pure direction," and all similar hypotheses of a oecial sense are quite unnecessary.

2. The phenomena which Cornetz sought to explain can all be cplained by natural causes. Without actually seeing distant bjects, an ant's visual apparatus may convey to it impressions ›ceived from them, which impressions may stimulate and influence ie creature's movements.

3. Only one lens of a compound eye can transmit direct rays 'om—say—the sun, and such direct rays must impinge on one articular point of the sensitive surface; the consequent sensation ›tting a particular nerve to work.

By so moving as to keep the light in the same direction, it is ossible to use the latter as a sort of compass to steer by; and iat the ant really does this is borne out by experiments with a iirror (deflect the rays and you upset the insect's steering! Re;ore the rays, and it can go ahead again!)

4. Differences in the lighting of various parts of the sky, and lso of large distant or near spaces and objects, restrictions of the orizon by hills, walls, trees and the like, may all affect the ant's optics," and through them its whole nervous system and moveıents thereby originated.

5. X-rays, electric conditions of the atmosphere, etc. etc., may e more or less perceived without any hypothetical special sense ır receiving them. Air-movements may be transmitted by sensive hairs, and become stimuli to movement in some particular irection.

6. Of course many movements of ants are results of actual sight, nell, and the like.

Brun has written a very long and learned paper on "antrientation"; it is full of very many technical and rather unwieldy ›rms, and I find the language (both as regards his German and his ıeaning) somewhat difficult to follow. He appears in the main to gree with Santschi, and he rejects all hypotheses of a special sense ossessed by ants only. If it is possible to state his views in a few ords, they appear to be something of this sort: Ant-orientation only a special case of "Orientation" in general, viz. a power ossessed in some degree by all living protoplasm of maintaining Static) or altering (Dynamic) the position in space of the whole ganism or any of its parts.

Static orientation being a matter of mechanical forces simply, g. the weight of the organism, the cohesion of its molecules, and

so forth. In Dynamic orientation the organism has power to "orient" movement toward some particular object. If this object is actually present to some sense (e.g. sight or smell) the orientation is direct: if not it is indirect, and in this case, which includes most of the more remarkable movements of ants, it is prompted by memory of past sensation or some sort of inference from present sensation (e.g. fatigue may tell an ant, returning to the nest, "I have expended so much energy on the journey and must be nearing home by this time.") Direct orientation will not explain all movements of ants, as we know that some of their senses are unequal to this, but indirect orientation probably will explain them, without any theory of a special sense. The extent to which any organism possesses the power of indirect orientation depends on its development generally, and more especially on that of its nervous system: the power of memory (i.e. recalling past sensations and being "oriented" by them) in greater or less development is hereditable, and includes reflex and instinctive stimulations, differing only in their comparative simplicity or complexity.

Any student who wishes to make a more complete study of this subject should read Brun's later papers; and especially a paper published by Santschi in 1923—"Les Différentes Orientations chez les Fourmis." (Rev. Zool. Africaine **12** 111–44 (1923).)

Enough has been said to show that ants are not merely reflex machines; they possess senses somewhat similar to ours in effect, though not in degree, and in many of their actions they are influenced by education, experience, and memory.

GEOGRAPHICAL DISTRIBUTION.

Ants are the most dominant of insects, their species are the most widely distributed, they outnumber in individuals all other terrestrial animals, and they range over the whole world between the extreme Arctic and Antarctic regions. These insects are by far most abundant in the tropics—forming there a powerful factor against which animals and plants have to contend—and becoming less numerous and important the nearer they approach the poles.

The ant fauna of the Palaearctic region proper (i.e. not including the Mediterranean region) is, relative to its large size, the poorest in the world. Considerably the largest ant fauna is the Neotropical, and next to it in numbers comes the Hindu-Malayan. A great relationship exists between the ants of the Nearctic and Palaearctic regions, an equally great difference being found between

those of the Nearctic and the Neotropical, the Neotropical and the Aethiopian, etc.

It is curious that some species in the extreme northern and southern faunas are very much alike; this is not on account of relationship but has been brought about by convergence, through the effects of a similar climate, etc.

GEOLOGICAL RECORD.

Fossil ants first make their appearance in the Tertiary period. Sharp states that they are amongst the earliest Hymenoptera, and that remains of these insects in the Lias of Switzerland and in the English Purbecks have been referred to ants. Handlirsch, however, has shown that those of the former formation certainly do not belong to the Hymenoptera, but presumably to the Homoptera, and that the latter (two wing impressions from the Lower Purbecks of Durdlestone Bay, considered by Westwood to belong to ants and described by him in 1854 as *Formicium brodiei* and *Myrmicium heeri*) belong to saw-flies.

Still, the remains of ants are so numerous in the early Tertiary, where the males, females and workers are as sharply differentiated as at the present day, that it seems probable they must have existed as far back as in the Trias, though they have not left any remains. Of the six hundred species of Tertiary Hymenoptera enumerated by Handlirsch, more than half are ants, representing a considerable number of genera many of which are still living. Tertiary ants have occurred in twenty-four localities in Europe and North America; only two of these localities—Gurnet Bay in the Isle of Wight, and the Bagshott Beds, Bournemouth—being situated in Britain. The remains of nine genera have been found there, the species of which are as follows:—*Syntaphus wheeleri* Donis.; *Euponera* (*Mesoponera*) *crawleyi* Donis.; *Ponera hypolitha* Cockerell; *P. minuta* Donis.; *Emplastus emeryi* Donis.; *Dolichoderus britanica* Cockerell; *D. anglicanus* Cockerell; *D. ovigerus* Cockerell; *D. vectensis* Donis.; *D. gurnetensis* Donis.; *Leucotaphus gurnetensis* Cockerell; *L. cockerelli* Donis.; *Oecophylla megarche* Cockerell; *O. atavina* Cockerell; *O. perdita* Cockerell; *Camponotus* (*Colobopsis*) *brodiei* Donis.

The above were all collected by P. B. Brodie and C. J. A'Court Smith in the Oligocene of the Isle of Wight. The locality is Gurnet or Gurnard Bay (both spellings appear in the maps), which lies a little to the west of Cowes in the north of the island. This deposit has been placed both in the Bembridge series = Middle Oligocene, and in the Osborne series which is Lower Oligocene, as also are the deposits of Aix and the Baltic amber. The Gurnet Bay fossils,

however, would seem to indicate a more decidedly temperate clin ate and consequently an age a little later than that of the Balti amber. There was perhaps a mud-spring, with heated waters, int which the insects fell, possibly overcome by gaseous emanation: The waters were not themselves poisonous, as fragments of roc carry also multitudes of a species of Phyllopod Crustacean, th *Branchipodites* described by Woodward in 1879. The theory cor cerning the mud-spring is supported by the fact that nearly a these fossil ants I have examined are winged, and were probabl overcome by the vapours during their marriage-flights. The ant which occur in the greatest abundance in this deposit are specie of *Oecophylla* and *Leucotaphus gurnetensis*. Cockerell has als described two fossil ants—*Oecophylla bartoniana* and *Formic heteroptera*—taken by J. S. Gardner in the Bagshott Beds, Bourne mouth.

The largest number of Fossil ants have been found in the Balti and Sicilian amber, and the beds of Radoboj, Oeningen, an Florissant.

Emery considers that the study of the ants of the Baltic an Sicilian amber proves that the Arctic fauna went down from th North as a host of conquerors.

Wheeler shows that of the forty genera found in these amber thirteen are extinct, and twenty-seven, or more than two-third are still living; moreover, some species of the Baltic amber ar almost, if not quite, identical with living species.

Emery accounts for the poverty of the European ant-fauna a follows: "My studies on the ants of the Sicilian amber hav demonstrated that at the beginning of the Tertiary, Europe ha an ant-fauna of Indoaustralian character, still living and exclu sively of this character in Sicily during the formation of the amber while to the north of the sea, which at that time extended acros Europe, representatives of this fauna, mingled with *Formica Myrmica* and other recent holarctic types, lived in the forests o the Samland. After the disappearance of this sea the norther fauna pushed its way southward as far as the Mediterranean. The came the Glacial epoch, which extinguished the Indian fauna i the north and drove its feeble remnants, mingled with arctic forms to the warmer localities of southern Europe. From these region the present ant-fauna wandered back, with the disappearance o the ice, into the middle and northern portions of the continent But the tropical forms had difficulty in returning, because th Mediterranean, the African deserts and the steppes to the eastwar were so many barriers to their progress. The European ant-faun therefore remains comparatively poor" (Wheeler's translation).

The reader who wishes to study more closely the palaeontolog of ants is referred to the works of Er. André, Emery, Handlirsch, Heer, Ma

COLLECTING.

Ants occur everywhere; in gardens and fields, in woods and copses, on heaths and open places, on mountains and in valleys, on the cliffs, and even in towns: but sandy and chalky soils appear to be the most productive situations. Colonies may be found under stones, bark, and at the foot of trees, in stumps and fallen branches, in hollow sticks, and galls, in banks, in the nests of other ants, and in houses.

When stray individuals are observed about, but their nest cannot be seen, the latter may often be found by carefully tracking workers returning to their dwelling laden with prey—sometimes over long distances. Some ants return direct to the nest, others wander about for some time, having apparently lost the track. Ants' nests most frequently face the east, and the side of a cliff, valley, or bank which is so situated will be found to be the best.

When a colony has been located, we should first note the situation of the nest, what it is made of, or how it is built, the behaviour of its inhabitants, what prey they bring home, whether any strange ants, parasites, or other myrmecophiles are on or above the nest, etc. The nest must then be treated differently according to whether the myrmecologist wishes to take the colony home, to obtain queens, or myrmecophiles, or only to study the habits, and capture a few of the workers. If a colony be situated under a stone, the latter should be carefully raised and the upper chambers and galleries of the nest examined, and unless it is desired to dig it up, the stone should be replaced in the same position as before. Should queens be required, the nest must be dug up at once and thrown on to a sheet, as if it is interfered with first, the queens may often escape; this is frequently the case with such species as *Formica rufa*. I have generally found it necessary, in the case of *F. sanguinea*, to dig up the whole nest at once with a spade and throw the earth, etc., on to a large sheet. In examining *F. rufa* nests for myrmecophiles, handfuls of débris should be taken from various parts of the nest and put into a bag, the contents of which may then be shaken bit by bit through a sieve over the sheet. All nest materials, etc., should be put back on to the nest, when the ants will quickly rebuild it. A little sugar placed on or near the nest will often prevent the ants from deserting their old quarters, which they frequently do if continually disturbed.

When a colony is to be taken home, it can either be put into a bag—with a few twigs or branches to prevent the ants from being crushed by the earth, etc.—or, if not too large, into tins. I have found it best, if possible, to secure the queen, or queens, separately, and put them into tubes, or glass-topped boxes, when they may be brought home in safety.

When collecting ants, the contents of different nests should

not be mixed, otherwise much confusion and error may result. To obtain the winged sexes is more difficult, as their times of appearance vary, and also when the collector requires males of a certain species winged females are often alone present, or vice versa. By carefully noting the situations of nests belonging to species of which the sexes are wanted, and visiting them continually at the times when the winged forms should be present, they may at last be secured. Males and females may also be bred by collecting the larger (sex) pupae or cocoons; these should be placed with a few workers in tins containing damp earth and a little honey. By these means I have secured the sexes of practically all our British species.

My outfit for collecting consists of a very strong fern-trowel, 12 inches long which fits into a sheath fastened to a leather belt—this is most useful both as a digger, and also to rip off bark, break up wood, etc.; some strong brown holland bags about 18 inches long and 14 inches in circumference; a white linen sheet, 66 inches long and 60 inches broad, one corner holding a pocket, into which débris, etc., placed on the sheet can be shaken, and the whole rolled up, thus forming a temporary bag; a small sieve with a fairly fine mesh; a pair of long tweezers with flat round edges to pick up ants, etc.; a pocket lens; a small cyanide bottle; a few glass-topped boxes; some tins, such as have contained cocoa, baking-powder, etc., and a flat tin box containing tubes, half of them empty, in which to bring ants, etc., home alive, the others being filled with the following mixture:—

5 ccs. strong acetic acid.
35 ccs. absolute alcohol.
60 ccs. of a $\frac{1}{500}$ solution of perchlor. mercury in water.

100

Ants, myrmecophilous coleoptera, etc., can be dropped into this solution, which quickly kills them, preserves them, and also does not render them too stiff to be set.

A note-book should be taken, in which to write down the ants observed, the condition and position of their nests, myrmecophiles present, etc. This note-book I copy out in full into a Journal at the end of each year, a record being thus kept of all observations made on ants from year to year.

I also possess a compact, but strong two-edged saw—one edge being composed of coarser teeth than the other—to cut through thick roots of trees, etc. Sometimes a spade, and even an axe, are required, but it is best not to carry more than is wanted for the day, or place, in question, as the less one has to carry the more usefully one can work.

A coleopterist's sweeping-net is sometimes of assistance, as

any ants swept up indicate that they come from a nest near at hand, which may subsequently be traced. The myrmecologist who wishes to take photographs of ants' nests in situ will also require a good camera. I use a reflex camera, with a good lens which can be mounted, with a ball and socket turn-table, on a very light tripod made of aluminium. The face of the camera can thus be pointed towards the ground, or in any other position required.

Mounting and Preserving.

British ants should always be completely mounted on card—ants should never be pinned, but for a general collection such as the Palaearctic Species, the Ants of the World, etc.—they should not be treated in the British manner, but should be glued on small triangular pieces of card, the body of the ant lying across the narrow end, and a long, stout insect pin being run through the broad end, in the continental manner. Three such cards and the data written on a small label may be staged on the same pin.

I personally first mount our species with gum tragacanth on any card stout enough not to curl up, their legs, antennae, and wings being set in the desired position. These cards, with full data written on them, are placed on the boards in my drying cages until the winter, when they are (card, pin and all) dropped into petrol and left there for twenty-four hours—this permanently removes all grease, and revives the colours. They are then removed, and, when dry, remounted on clean cards; this is easily done with a fine paint-brush and a little water, a drop of strong gum being placed on the underside of the ant only, as sufficient tragacanth remains on the legs, etc., to keep them in position, though it does not show. Each ant is remounted on a single oblong piece of white Bristol board, which has been cut to the required size with a card-cutter, and the locality, date of capture, etc., is written on the underside of the card itself. These cards are fastened into the cabinet drawer with small English "Lill" pins, the top halves of which have been cut off. For the proper study of ants a large series is necessary, I therefore keep two collections. The one is a show collection and is arranged in cabinet drawers; it consists of three or four males, the same number of females (half of the latter being winged, half deälated), and sixteen to twenty workers of each species—for this collection only, specimens are remounted. The other is a duplicate collection, and is kept in a number of store-boxes; specimens of each species (a few mounted on their backs, others dissected, etc.) are present from as many different British localities as possible, and also males, females, and workers from the same, as well as from different colonies. I also possess a large collection of the ants of the world, but this does not concern us here.

It is obvious that the cards may be staged on long pins if desired, and may be arranged in cabinets, or store-boxes, in any manner the student may prefer.

It is necessary to have a compound microscope as well as a good hand lens—when describing all our genera and species for this work, I have used a binocular microscope and a magnification of 35 diameters.

Ants may be killed with boiling water, in cyanide, laurel, or in the solution before mentioned. In the first case they must be set at once, but if killed in cyanide, or laurel, they can be kept for long periods. For this purpose a large wide-mouthed laurel bottle is convenient, such as is used by the coleopterist; into this the ants are dropped in screws of tissue-paper, with the data written on slips of paper inside each screw. Ants will be found to be in perfect condition for setting when kept in this way, even after twelve months, or longer.

The instruments for setting, such as brushes, setting-needles, tweezers, gum, card, etc., do not require description, as the myrmecologist will select, from experience, those which he finds most suitable to him.

Observation-Nests.

To gain a proper knowledge of the normal conditions under which ants live it is necessary to study their habits as closely as possible in nature, at all times of the day and year, in all weathers, and in different localities. When a nest has been found, it should not be passed over just because it may belong to a common ant, or because the species may be fully represented in the observer's cabinet, as the mere amassing of a collection is only the means to an end, and not the sole object in view—namely to increase as far as possible the knowledge on all points concerning ants.

If a suitable locality exists within easy reach, it should be constantly visited at different times of the year, the situations of the nests of the different species noted, and their contents and the progress of their colonies carefully studied. Such a locality is Weybridge Heath, a favourite observation ground of my own, with its sandy soil, fir trees and stumps, young oaks and birch, and heather, etc. Here no less than eighteen of our British species of *Formicidae* have been found, and many happy hours during the last thirty years and more have been spent in examining their nests and watching their habits.

To observe, however, the actual doings of the ants in the depths of their dwellings is naturally almost impossible, as when an ant's nest is disturbed a scene of apparent chaos ensues; the ants all rush about, some attack the intruder, and others hurry off into safety with their brood, etc.

To obviate this as far as possible the myrmecologist must keep

ants in captivity, and for this purpose "observation-nests" are used. Swammerdam in 1737, and Huber in 1810, described artificial nests in which they confined ants, and many observers to the present day have invented, or modified, described, and figured, different forms of nests which they have used for the same purpose; such are: André, Brun, Crawley, Ders, Donisthorpe, Emery, Escherich, Miss Fielde, Forel, Janet, Kneissl, Lubbock, Newell, Overloop, Santschi, Schmitz, Viehmeyer, Wasmann, Wheeler, etc.

The two principal types of observation-nests are Lubbock's glass nests and Janet's plaster nests; nearly all the others are a modification in some form or other, or a combination of these.

Lubbock describes his nest as follows: "After trying various plans, I found the most convenient method was to keep them in nests consisting of two plates of common window glass, about

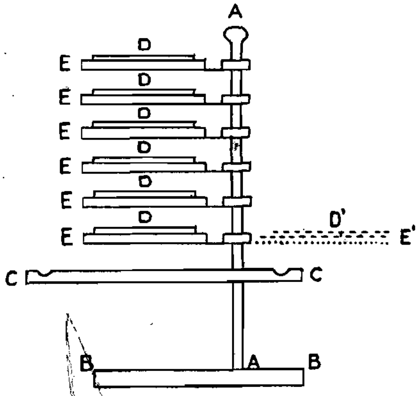


Fig. 51. Stand for nests described by Lord Avebury.

ten inches square, and at a distance apart of from $\frac{1}{10}$ to $\frac{1}{4}$ in. (in fact, just sufficiently deep to allow the ants freedom of motion), with slips of wood round the edges, the intermediate space being filled up with fine earth. If the interval between the glass plates was too great, the ants were partly hidden by the earth, but when the distance between the plates of glass was properly regulated with reference to the size of the ants, they were open to close observation, and had no opportunity of concealing themselves. Ants, however, very much dislike light in their nests, probably because it makes them think themselves insecure, and I always therefore kept the nests covered over, except when under actual observation. I found it convenient to have one side of the nest formed by a loose slip of wood, and at one corner I left a small door. These glass nests I either kept in shallow boxes with loose glass covers resting on baize, which admitted enough air and yet was

impervious to the ants; or on stand surrounded either by water, or by fur, with the hairs pointing downwards. Some of these nests I arranged on stands, as shown in the figure. AA is an upright post fixed on a base BB. CC is a square platform of wood round which runs a ditch of water. Above are six nests, D, each lying on a platform E, which could be turned for facility of observation, as shown in the dotted lines D′ and E′. Thus the ants had a considerable range, as they could wander as far as the water ditch. The object of having the platform CC larger than the supports of the nests was that if the ants fell, as often happened, they were within the water boundary, and were able to return home. This plan answered fairly well, and saved space, but it did not quite fulfil my hopes, as the ants were so pugnacious that I was obliged to be very careful which nests were placed on the same stand. Of course it was impossible to force the ants into these glass nests. On the other hand, when once the right way is known it is easy to induce them to go in. When I wished to start a new nest I dug

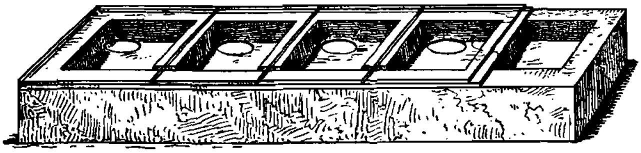


Fig. 52. Four-chambered "Janet" plaster nest.

one up, and brought home the ants, earth, etc., all together. I then put them over one of my artificial nests, on one of the platforms surrounded by a moat of water. Gradually the outer earth dried up, while that between the two plates of glass, being protected from evaporation, retained its moisture. Under these circumstances the ants found it more suitable to their requirements, and gradually deserted the drier mould outside, which I removed by degrees. In the earth between the plates of glass the ants tunnelled out passages, chambers, etc., varying in form according to the circumstances and species. Even between the plates of glass the earth gradually dried up, and I had to supply artificial rain from time to time. Occasionally also I gave them a new nest. They seem, however, to get attached to their old homes, and I have one community which has inhabited the same glass case ever since 1874." (About eight years). "It is hardly necessary to say that the individual ants belonging to the communities placed on the stands just described, knew their own nests perfectly well."

Janet's type of nest is quite different from the above, it is made of

laster, or some other porous material, with a glass roof, and no arth is employed. His nest consists of three chambers, which re situated in a block of plaster of Paris, and are connected with ach other by galleries. A fourth space, which is narrower than the ther three and is not connected with them, serves as a water-rough. A sheet of glass covers in the three chambers; this has hree holes in it, one over each chamber, and other sheets of glass lose these holes. Water is poured into the water-trough once or wice a week to keep the nest damp, and the nest is placed on a heet of glass to prevent the moisture from reaching the table on hich it stands. The chamber furthest from the water-trough is aturally the dryest, and is exposed to the light, the other two amper chambers being covered over with some opaque material. he food for the ants is placed in the light dry chamber, which repre-ents the outside world, and the two dark chambers represent the iterior of the nest.

The following other observation-nests may be mentioned which re used by different myrmecologists.

Wasmann employs two "Lubbock" nests, which are connected ith each other by a glass tube. The larger of the two—the main est, which contains the colony of ants—is connected with various lass vessels, etc., containing earth and food, to serve as playing-nd dumping-grounds for the ants.

Miss Fielde uses a form of "Lubbock" nest, which may consist f two, or three, chambers; strips of glass, instead of wood, form he walls of the nest, held in place by crockery cement. The walls nd partitions are topped with Turkish towelling, a glass roof-pane or each chamber resting on it. No earth is present, and slices of amp sponge are placed in the one or two inner dark chambers o supply the necessary moisture.

Wheeler combines a "Janet" and a "Fielde" nest, by construct-ig the whole of the body of the apparatus of plaster of Paris, the iterior being thickly coated with varnish. The glass roof-panes rest n Turkish towelling, and the sponges are used, no earth being resent.

Emery makes a modified "Janet" nest from tiles which are erforated with holes. The tiles are ground down to the required hickness, the holes on the side which forms the bottom of the est are closed with plaster of Paris, and the top is covered by a late of glass.

Brun has substituted a block of peat to take the place of the laster of Paris walls and partitions of a "Janet" nest, the top and ottom being covered with glass.

A small artificial nest for colonies of diminutive ants, which have o be kept in very tight receptacles, is constructed by Santschi as ollows: "The base of the nest consists of a rectangular glass plate, uch as is most conveniently obtained by cleaning an unsuccessfully

exposed photographic plate of ordinary dimensions, say 3 × 4 or 4 × 5 in. Wet plaster of Paris is poured on to this plate in the form of the heavy lines in the accompanying diagrams, which represent nests with two or three chambers respectively, connected by galleries. Of course any other design which suggests itself as suitable may be used instead, if desired. Before the plaster has set, a second plate of the same size and shape as the base and previously covered with a film of sweet oil, is pressed down on to the plaster till it

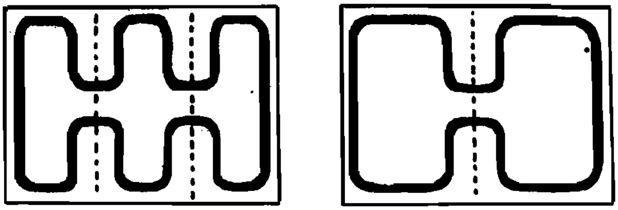


Fig. 53. Small " Santschi " observation-nests.

forms walls only a few millimetres in height. After the plaster has set, the roof-pane is removed, cleaned and cut into two or more pieces with a diamond along lines (dotted in the figures) which bisect the short galleries, and then replaced as covers of the chambers. The ants can be introduced into the nest by sliding the covers apart a short distance over one of the galleries. The plaster is

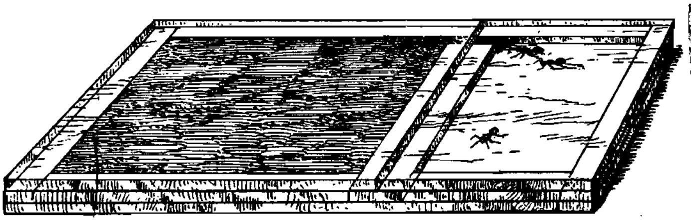


Fig. 54. " Crawley-Lubbock " observation-nest.

sufficiently porous to provide for ventilation and a thin slice o wet sponge, or a tuft of wet moss or cotton, placed in one of th chambers will furnish the requisite amount of moisture." Sucl nests can be placed on the stage of a compound or binocular micro scope, and studied under a low objective.

Crawley has improved on the Lubbock type of nest as follows " The nest consists of two panes of glass, one foot square, witl slips of thick glass, ¾ in. wide, round the edges, so as to form a frame, leaving a space of nearly ¼ in. between the upper and lowe

tom glass is a layer of plaster of Paris, reducing the interval between the glass panes to $\frac{1}{8}$ in. The space between is filled with fine earth." The earth should be placed on the layer of plaster before the latter is dry, and the advantage of this nest is that it retains moisture for a longer period than an ordinary "Lubbock" nest. These nests may be made of different sizes if desired; as in the "Fielde" nest, glass strips are used instead of wood, and a second chamber may be added, kept light and without earth, to serve as a feeding and exercise ground. When a second chamber is present the apparatus is entirely shut in and requires to fit more accurately; plate glass $\frac{3}{16}$ or $\frac{1}{8}$ in. thick should be used, and all the parts of the nest should be cut from the same sheet of glass.

Viehmeyer has modified the "Janet" nest by enclosing it with a zinc bottom, and adding metal strips across the top; the latter prevent the glass covers from slipping. Though this arrangement enables the nest to be more easily moved about, it naturally makes it heavier to carry. Crawley formerly had made a heavy, large four-chambered "Janet" nest, the plaster of Paris being thicker in depth and width. These nests are admirable to leave, when away from home, as when well watered they retain the moisture for a long time.

The nest I most frequently use, and find most convenient on the whole, is a four-chambered "Janet" nest, lighter and smaller than the above. This nest is made by Messrs. Doulton and Co., Ltd. (Archtl. Dept.), Lambeth, from directions supplied to them by Crawley and myself, and can always be obtained there. The glass for the roof requires to be purchased separately, and can be used with, or without, the openings over the chambers. It may be held in position by brass springs, clips, or some other arrangement.

For the reception of such large species as *Formica rufa*, etc., with their natural nest-materials, I invented a large artificial nest. The frame-work is made of wood, 14 in. in height, breadth, and length, standing on four legs 4 in. high. Four panes of glass 12 in. square fit into grooves in the wooden frame, and form the sides. The bottom is made of perforated zinc, over which is laid a thick layer of plaster of Paris, and the top is left open. This nest stands in a large zinc tray, the outside of which consists of a trough to hold water about an inch and a half wide and two inches deep. Between the sides of the legs of the nest and the trough there is space about two inches wide. A layer of sand, five or six inches deep, is placed over the plaster in the nest. When a colony is introduced a mass of the materials of the nest, with the ants, etc., just as it was collected, is shot from a bag into the nest. Care must be taken that a queen, or queens, have been secured, and these are introduced separately. The ants soon tunnel into the sand, and build up and arrange the nest materials as in nature.

Fresh pine-needles, etc., may be thrown in from time to time, which the ants will add to their hillock, and they use corners of the zinc tray for cemeteries and "kitchen middens." Though this form of nest does not enable one to study the behaviour of the ants in the interior of the nests—except that they bring the eggs and larvae to the side of the glass pane nearest the sun, or a fire, beneath the nest materials—much may be learnt about their habits by watching it, and many flies and other myrmecophiles may be bred out, which would not occur in "Lubbock" and "Janet" nests. The nest can be enclosed with muslin attached to a wire frame which extends from outside the water-trough over the nest and does not touch it anywhere. In this way any winged creature, which may have

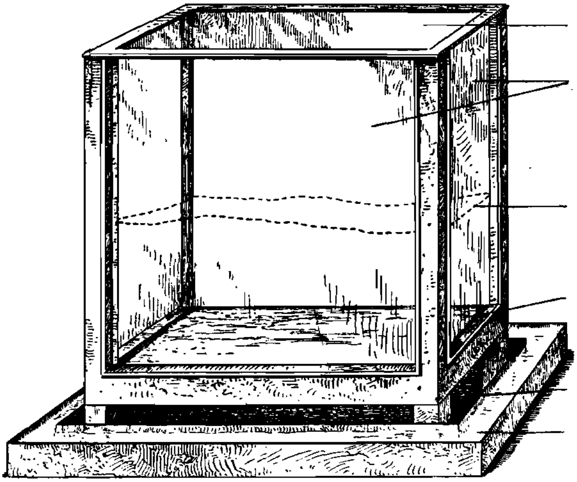


Fig. 55. "Donisthorpe" observation-nest.

hatched out when the observer is not present, will not be lost. (For the same purpose I have used large glass bowls containing sand; the earth, or other materials, dug up with the colony, from an ant's nest is shot into them, and the top is covered with muslin. In these bowls I have bred a number of myrmecophiles, which had not been discovered before.)

This nest (and the bowls) occasionally require to be thoroughly watered with a child's watering-can, or some such apparatus.

The water-trough prevents those ants which go down into the tray, where they walk about freely, from escaping into the room. It is not, however, entirely satisfactory, as some manage to swim across, and when the water gets covered with a film of dust, others walk over it. Some people allow petrol to float on the top of the

ter; the ants do not like it, but those that may happen to fall are killed.

Newell, after trying very many different oils and disinfectants, for this purpose without success, eventually placed his ants' its on galvanized iron trays, through which running water inches deep was kept passing day and night. Ants will move h their brood into either "Lubbock" or "Janet" types of nest, laced with them on a tray or table enclosed with a water moat, in a "Forel arena." The latter is constructed as follows:—

n a table, or large board, a circular or elliptical enclosure a w feet in diameter is made by laying down a wall of dry, powdered laster of Paris about two or three inches broad and an inch high. he inner edge of this wall is made smooth and steep with the aid f a putty or case knife. The artificial nest, with its chambers oistened and darkened, is placed in this arena. Then the colony be installed, together with its brood and the earth of its nest, dumped from the collecting bag into the arena just as it was rought in from the field. The ants are at first much excited and ander about in the enclosure, but are unable to scale its crumbling alls. They soon learn to avoid the powdery plaster, find the ntrance of the nest and migrate into it with their whole brood, nd any myrmecophiles they may have. This migration is hastened y spreading out the earth from their old nest so that it may dry. Vhen the colony has entered, the nest opening is plugged with otton, and the nest is removed from the arena."

I personally use a wooden box, with a tightly-fitting lid, which have had made for this purpose. This box is eighteen inches long, welve inches broad, and twelve inches deep; a pane of glass eing let into the front. Two small holes have been bored through ne side of the box near the bottom, and on the opposite side a rger hole has been cut, these holes being corked with wooden lugs. A bag, or tin full of ants, earth, etc., just as they were dug p, are shot into this box, the lid closed, and a glass tube fitted one of the smaller holes. This tube is connected with a watered nd darkened plaster nest, and as the contents of the box get dry, e ants soon find their way through the tube into the nest. Should e ants refuse to leave the box, or take too long in migrating, rbon, or cotton-wool dipped in ammonia can be inserted through e larger hole to hurry them up. Prepared "Lubbock" or Janet" nests can also be placed inside the box previous to the troduction of the ants; this takes the place of a "Forel arena." This box has the advantage that it can be taken into the field, d the desired ant colony, etc., transferred directly into it—a large rton nest, such as that constructed by *Acanthomyops fuliginosus*, much best treated in this way. I have kept ants in captivity r many years past, including all the British genera, and nearly l the species, besides some continental and exotic ones.

INDIGENOUS GENERA AND SPECIES.

The *Formicidae* or ants (also * called *Heterogyna* owing to the tendency of the female to assume different phases) form a natural family which was until recently divided into five subfamilies—I *Ponerinae* Mayr, II *Dorylinae* Shuckard, III *Myrmicinae* Mayr, IV *Dolichoderinae* Forel, and V *Camponotinae* Forel.

In 1920 Wheeler, after studying a great number of ant larvae of many genera and subgenera in all five subfamilies, proposed to raise two more subfamilies—the *Pseudomyrminae* and the *Cerapachyinae*. Personally I consider that, by the arguments he produced, Wheeler was justified in this proceeding. Moreover, he used the name *Formicinae* for the subfamily usually called *Camponotinae*. Forel in 1878 divided Mayr's subfamily *Formicidae* (1855) into *Dolichoderinae* and *Camponotinae*, and he justified this because *Formicidae* was already in use as a family name. According to our present rules, and the use of " inae " as a suffix for subfamily names, he should have retained Mayr's name, and restricted it to the group containing *Formica*.

Only four of these subfamilies occur in the British Isles; these may be distinguished as follows :—

Table of Subfamilies.

1	Pedicel distinctly two-jointed in all the sexes	2 *Myrmicinae.*
–	Pedicel not two-jointed	2
2	Gaster constricted between its two first segments........	1 *Ponerinae.*
(1)	Gaster not constricted	3
3	Gaster with five segments visible from above; anal aperture circular surrounded with a fringe of bristles..................	4 *Formicinae.*
(2)	Gaster with only four segments visible from above; anal aperture forming a transverse slit, not circular nor surrounded with bristles	3 *Dolichoderinae.*

Forel has estimated that considerably over six thousand species, subspecies, and varieties of ants are known in the world; this number, no doubt, will be largely augmented by further descriptions and discoveries.

In Britain we possess thirty-five species (including those which used to be called races or subspecies, and a few which many authors still regard as such), and twelve varieties.

* Ants were anciently called Emmets, or Pismires. In an old dictionary (1755) in my possession, the derivation of the latter word is given—" Piese (Dutch), a heap ; and Myre (Danish), an ant ; because it throws up heaps of earth." Shakespeare makes Hotspur say [Henry IV, Act I, Scene 3]—

> " Why, look you, I am whipp'd and scourg'd with rods,
> Nettled, and stung with pismires. . . ."

Subfamily **Ponerinae** Mayr.

The subfamily *Ponerinae* comprises many different tribes, by far the larger number of which are to be found in the tropics. In Australia the *Ponerinae* become a dominant group, where they may be compared with the marsupials and other characteristic animals of that region.

These are the most ancient and primitive forms of ants now living, both in habits and structure; their colonies are mostly small, they are all predaceous and carnivorous, their pupae are always enclosed in cocoons, and a well-developed sting is always present in the worker and female.

We only possess one genus in Britain—*Ponera* Latreille—the species of which are found in the earth, under stones, in rotten wood, and in vegetable refuse, in both the hot and temperate regions of the whole world.

In 1810 Latreille [Cons. Gén. Crust. Ins. **311** No. 443, 437 (1810)] cited *Formica crassinoda* (Latr.) F., as the type of *Ponera*, but he had already in 1805 [H.N. Crust. Ins. **13** 257–8 No. 365 (1805)] cited *contracta* as type.

PONERA Latreille.

(*πόνηρός*, laborious.)

Type : **Formica coarctata** Latr. (=*contracta* Latr.; Latr., 1805).

☿ *Head* oblong oval, quadrangular; *clypeus* triangular, narrow, arched, and produced posteriorly; *mandibles* long, triangular, with the terminal border dentate and longer than the internal border; *maxillary-palpi* one- or two-jointed; *labial-palpi* two-jointed; *antennae* stout, twelve-jointed, with a four-jointed club, first joint of *funiculus* longer and broader than the second; *frontal-carinae* short, convergent, only separated by the frontal furrow; *eyes* very small, situated in front; *ocelli* wanting. *Thorax* narrower than head, convex, truncate posteriorly, with sutures distinct. *Pedicel* plainly separated from the gaster, furnished with a thick scale which is rounded above, somewhat convex in front, truncate behind, and as high as the gaster. *Spurs* on all the legs pectinate. *Gaster* as long as thorax, cylindrical.

♀ very like the ☿; *eyes* much larger; *ocelli* present. *Fore wings* with two cubital and one discoidal cell.

♂ somewhat like the ☿; *mandibles* narrow and short, not dentate; *maxillary-palpi* four-jointed; *labial-palpi* three-jointed; *antennae* twelve- or thirteen-jointed, scape a little longer than the first joint of the funiculus, the latter being short and subtransverse, the rest of the joints of the funiculus elongate and filiform; *eyes* and *ocelli* larger than in the ♀. Wings as in the ♀, legs longer and more slender than in the ☿ and ♀.

Original description (Latreille Nouv. Dict. d'Hist. Nat. **24** 178–9 (1804)):—

"II. Antennes insérées très près du bord antérieur de la tête.

1. Antennes grossissant insensiblement vers leur extrémité; premier article faisant presque la moitié de leur longueur, dans les femelles et les mulets; tête épaisse; abdomen ovoïde ou conique; (palpes maxillaires de la longueur au moins des mâchoires, sensibles, de quatre à six articles).

A. Premier article des antennes toujours découvert.
B. Un aiguillon dans les femelles et les mulets.
a. Second anneau de l'abdomen separé au plus du suivant par un léger étranglement : pédicule de l'abdomen n'étant pas formé de deux nœuds très distincts.
** Mandibules des mulets triangulaires.
Genre Ponère, *Ponera*.
Mes F. *étranglées*, à l'exception de la quatrième subdivision.—F. *tarsata*, *clavata* Fab."

Table of the Species.

Two species of *Ponera* are found in Britain, which may be distinguished as follows :—

☿

Maxillary-palpi two-jointed ; more coarsely punctured . . . . *coarctata* Latr.
Maxillary-palpi one-jointed ; very finely and closely punctured — — — — — — *punctatissima* Roger.

♀

Eyes not near base of mandibles, smaller ; head narrower . . . . *coarctata* Latr.
Eyes near base of mandibles, larger ; head broader — — *punctatissima* Roger.

♂

Winged ; antennae thirteen-jointed ; pygidium armed with a spine . . . . *coarctata* Latr.
Apterous ; antennae twelve-jointed ; pygidium simple – *punctatissima* Roger.

Ponera coarctata Latr.

Formica coarctata Latreille Bull. Soc. philom. Paris 3 No. 57, 65 (1802)[1]. *Formica contracta* Latrielle Hist. Nat. Fourmis 195 (1802)[2]. *Ponera contracta* Latreille Hist. Nat. Crust. Insect. 13 257 (1805)[3] ; Stephens Ill. Brit. Entom. Sup. 15 (1846)[4] ; F. Smith Trans. Ent. Soc. Lond. (n.s.) 3 114 (1855)[5] : Ent. Ann. **1857** 34[6] : **1858** 39[7] : Cat. Brit. Foss. Hym. 19 (1858)[8] : Ent. Ann. **1866** 128[9] ; Baly Entom. 6 259 (1873)[10] ; Forel Denkschr. Schweiz. Ges. Naturw.

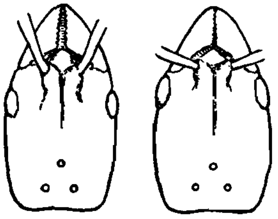


Fig. 56. 1. Head of *Ponera coarctata* ♀.
2. Head of *Ponera punctatissima* ♀.

26 62 (1874)[11] ; B. Cooke Nat. 5 73 (1879)[12] ; Parfitt Trans. Devon Assn. Sc.-Art **12** 515 (1880)[13] ; Saunders Trans. Ent. Soc. Lond. **1880** 212[14] ; Dale Ent. Mo. Mag. **17** 236 (1881)[15] ; Lubbock Lin. Soc. Journ. Zool. **27** 51 (1883)[16] ; Fowler Ent. Mo. Mag. 21 38 (1884)[17] ; Capron Ent. Mo. Mag. 22 264 (1886)[18] ; Wasmann Tijdschr. Entom. 34 49 (1891)[19]. *Ponera coarctata* Dalla Torre Cat. Hym. 7 38 (1893)[20]. *Ponera contracta* D. Sharp Trans. Ent. Soc. Lond. **1893** 203[21] ; Farren-White Ants' Ways 238 (1895)[22] ; Saunders Hym.-Acul.

9 (1896)[23]; Bradley Ent. Mo. Mag. 33 46 (1897)[24]; E. A. Butler Ent. Mo. Mag. 35 290 (1899)[25]; Donisthorpe Ent. Rec. 14 16 (1902)[26]; Chitty Ent. Mo. Mag. 39 69[27], 283[28] (1903): 42 212 (1906)[29]; Vic. Hist. Durham 1 95 (1905)[30]; Vic. Hist. Cornwall 1 182 (1906)[31]. *Ponera coarctata* Wasmann Arch. Trim. Inst. Grand-Ducal Luxemburg **1906** 13[32]. *Ponera contracta* Vic. Hist. Kent 1 116 (1908)[33]. *Ponera coarctata* Emery Deutsch. Ent. Zeitschr. 1909 369[34]; Wheeler Ants 96[35], 174[36] (1910); Donisthorpe Ent. Rec. 23 3 (1911)[37]: Entom. 44 389 (1911)[38]; Emery Gen. Ins. 118 90 (1911)[39]; Donisthorpe Ent. Rec. 24 4 (1912)[40]: 25 61 (1913)[41]; Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 2 14 (1913)[42]; Emery Bull. Soc. Ent. Italiana 47 106 (1916)[43]; Donisthorpe Ent. Rec. 28 1 (1916)[44]: 36 49 (1924)[45].

☿ *Dark brown somewhat shining, hairy especially on the gaster, but with scarcely any pubescence, mandibles, clypeus, antennae, legs, and extremity of the gaster reddish yellow—sometimes the whole insect is of a reddish yellow colour.*

Head black, duller and more closely punctured than the thorax and gaster; *mandibles* with terminal border furnished with three or four stronger teeth in front and indistinctly dentate posteriorly; *maxillary-palpi* two-jointed, the last joint terminated by a single hair; *gaster* beneath, strongly rugose transversely at the anterior portion of the second segment. *Long.* 3–3·5 mm. (2½–3½ mm. *teste André.*)

♀ *Very like the* ☿; *eyes* about the same distance, or a little farther, from the base of the mandibles, as their own length. *Long.* 4–4·5 mm. (3–3¾ mm. *teste André.*)

♂ *Shining black, legs and antennae brown, puncturation much finer than in the* ☿.

Head trapezoidal, rounded behind; *antennae* thirteen-jointed, scape and first joint of funiculus short, somewhat smooth and shining, the other joints of the funiculus elongate and pubescent. *Thorax* high; *scutellum* arched; *post-scutellum* projecting. *Pygidium* terminating in a spine. *Long.* 3·4–3·8 mm. (2½–3½ mm. *teste André.*)

Ovum: long, cylindrical (some individual eggs, however, appear to be shorter) and yellowish white in colour.

Larva: *Head* fairly large, with strong, horny mandibles, body clothed with bristle-capped tubercles, and four pairs of glutinous club-shaped tubercles, situated on the dorsal part of the sixth and following somites.

Pupa: enclosed in somewhat dark cases.

Original description of *Ponera coarctata* Latreille [Bull. Soc. Philom. Paris 3 No. 57, 65 (1802)]:—

"Operaria. Elongata, subcylindrica, fusco-brunnea; oculis nullis aut obsoletis; squama nodiformis, subcubica, antennis pedibusque flavescentibus. Long. ·0,004. = 1 lig. ¾."

Habitat.

Ponera coarctata occurs in South Europe, the Caucasus, and Algeria, and extends northwards to Paris and Aachen[34], two varieties occurring in Europe, and three subspecies—in Australia, Africa, and N. America[39].

The British distribution is as follows:—

Cornwall, E.: Mount Edgcumbe[31].

Devon, S.: Plymouth (*Reading*)[13]; Exeter (*Parfitt*)[13]; Brixham and Paignton (*Perkins*).

Isle of Wight: Ventnor (*Dale*)[15]; Sandown (*Fowler*)[17].

Dorset: Swanage (*Nevinson*); West Lulworth Cliffs (*Haines*).
Hants, S.: New Forest (*Hamm*).
Sussex, E.: Brighton (*Power*)[7]; Pett (*Bennett*).
Kent, E.: Deal (*Dale*)[15]; St. Peter's[45] and Doddington (*Donisthorpe*)[26]; Throwley[33], Charing[27], and Chatham (*Chitty*)[28]; Folkestone (*Power* VI. 60, Rothney Coll.); **Kent, W.:** Upnor (*Power* X. 65, Rothney Coll.); Darenth Wood (*Donisthorpe*)[37].
Surrey: Mickleham (*D. Sharp*)[9]; Merton (*Power*)[9]; Shere (*Capron*)[18]; Weybridge (*Billups*)[23]; Gomshall (*E. A. Butler*)[25]; Stoat's Nest (*W. E. Sharp*)[37]; Chipstead (*Bedwell*); Box Hill (*Donisthorpe*)[37]; Wandsworth (*F. H. Waterhouse*).
Middlesex: St. James's Park (*Westwood*)[5]; Kentish Town (*Baly*)[6]; Chelsea and Pimlico (*Westwood* and *Ingpen*)[4].
Warwick: Warwick (*Baly*)[10]; Sutton Coldfield (*Bradley*)[24].
Lancashire, S.: near Manchester (*Cooke*)[12 23].
Durham: South Shields[30].

Ponera coarctata was first discovered in Britain by Professor J. O. Westwood[5], who captured it in St. James's Park in London. It has been suggested that its headquarters are situated in Kent, east of the Medway[28], but this is hardly the case since—as has been seen—it ranges from Cornwall as far north as South Shields in Durham.

According to Professor Wheeler[36] the similarity between our species and *Ponera atavia* of the Baltic amber is so intimate that it is impossible to distinguish them by any satisfactory characters —a fact which emphasizes its antiquity.

It is generally sluggish in its movements, and subterranean in habits, forming its nests under stones, etc., but it is often found in moss, when, however, it is no doubt in search of its food, which consists of small insects and mites, etc. A female was captured by Westwood[6], attracted to pieces of meat laid in his garden as baits for insects.

It possesses the power of stridulating, the apparatus by which it accomplishes this having been described and figured by Dr. Sharp[21]. The dorsum of the third gastric segment is extremely coarsely and remotely sculptured at its base, while in the middle there is a band of very fine lines, quite unlike the rest of the sculpture. Its colonies are always small, consisting of very few individuals; five or more deälated females may be present—rarely ergatogynes[35] and more rarely microgynes[34] occur, though I am not aware of any captures of these two forms in Britain.

Morley found a colony in August, 1903, at Charing under a stone, which contained some twenty-five pupae, a lesser number of workers, and a deälated female. Chitty[28], who recorded this, thought that this was the first time a nest of this ant had been found in Britain, but Lord Avebury[16] recorded in 1883 the discovery of a nest under

stone, the community consisting of about twenty individuals. ater, in August, 1903, Chitty[28] observed a small deposit of pupae id a few workers at Charing, and near Doddington a few workers ıder a stone, with evident traces of very fine galleries drilled by ıe ants in the earth. The following nests have been found by e :—July 22nd, 1906, when in company with Chitty, two nests ıder stones at Charing which contained a number of worker ıpae[28]; May 1st and 8th, 1910—two small colonies under flints ; Box Hill which contained five and three deälated females re- ectively, and a small number of workers[37]; May 26th, 1911—a ıall community in moss at Box Hill with two deälated females ıd a few workers[40]; May 16th, 1913—two more colonies under nts at Box Hill with respectively one and two deälated females ıd some twelve workers. The nest with the two females consisted a cell—in which they rested with a packet of eggs—just beneath ıe stone, built round with earth, through which long, narrow gal- ries stretched in every direction. June 15th, 1915—three deälated males and seven or eight workers were found when digging up a ıst of *Myrmica scabrinodis* at Box Hill. They were evidently ɔt really living in the *Myrmica* nest, as when introduced with ıe colony of the latter into an observation-nest, the *Myrmica* orkers killed them all in a few days[44]. August 8th, 1923—a few orkers were dug up with seed potatoes at St. Peter's, Kent[45].

The males and winged females are to be found in August and ɜptember, and may be swept off herbage in the neighbourhood of ıe nests. Baly[6] observed a winged female which flew into an open indow in his house in Kentish Town, and settled on the page of the ɔok he was reading. Chitty[29] records males on August 28th, 1904, ıd September 3rd, 1905, and one winged female on the latter date, l at Charing, and Hamm captured a female on the wing in the ew Forest in August, 1908. I have taken five winged females at arenth Wood on September 27th, 1910[37], and swept many males ıd one winged female at Box Hill on September 5th, 1912[41]— ıis female had evidently been fertilized, as she had lost two wings, ıd when placed in a tube with some males, refused to allow them embrace her. In September, 1913, none could be found, and ı September 2nd, 1914, only one male was swept at the same spot.

Specimens of this ant are frequently found in and about other ıts' nests—both Janson[22] and Shepperd[22] took workers in company ith *Acanthomyops fuliginosus*, W. E. Sharp[37] workers with *A. flavus* ; Stoat's Nest, and my own captures are as follows :—a worker ith *Formica fusca* at Doddington[26], May 12th, 1901; five winged males and a few workers in a nest of *A. fuliginosus* at Darenth ood, September 27th, 1910[37]; a worker in the same nest May ɜth, 1911[40]; and a number of workers with *F. fusca*, Box Hill, ay 30th, 1912[41]—some of these were brought home and introduced to two observation-nests of *F. fusca* (from Porlock and Tiree),

where they lived for more than two months, and were never attacked by the *fusca* workers, crouching down and remaining motionless when the latter tapped them with their antennae. A deälated female and five workers were found in a nest of *F. fusca* at Box Hill on May 4th, 1923. These were taken home and put into a small plaster observation-nest; but they unfortunately escaped during my absence from home[45].

Wasmann records specimens in the neighbourhood ("Nestbezirke") of nests of *F. rufa* and *F. sanguinea* in Dutch Limburg[19], and often with other ants in Luxemburg[32]. It is possible that females of *Ponera coarctata* may found their small colonies in, or near, the nests of other species of ants for the sake of the food and shelter they may thus obtain[42].

The following Myrmecophiles have occurred with this ant in Britain:—*Drusilla canaliculata* F., *Lamprinus saginatus* Gr., and *Bythinus glabratus* Rye (Coleoptera), *Pseudisobrachium cantianum* Chitty (Proctotrupid), *Cyphodeirus albinos* Nicolet (Collembola), and *Ripersia donisthorpei* Newstead (Coccid), but *Aphidae* do not appear to be attended, or kept, by it, as is also pointed out by Forel[11].

Colonies have not been kept in captivity with much success—the one referred to by Lord Avebury was unfortunately destroyed by a community of *Acanthomyops flavus*[16]; Chitty placed Morley's colony in a small inverted glass shade with earth on August 2nd, when the ants disappeared beneath the earth, and were not seen again till September 20th, when he dug them up and found some twenty workers present, a deälated female and two males[28]—he states that all the pupae had hatched; but it seems probable that the latter were all sex pupae and most of them had been devoured by the workers, since the ants were not observed to have eaten anything; he again kept a small community in damp moss, but this proved a failure, the ants dying and the pupae withering up[28]; four deälated females and some twelve workers were kept by me in a small plaster nest, the ants would not touch the honey given to them, but eagerly devoured small flies, they, however, all gradually died off, the females not being observed to lay any eggs[37]; another small colony was kept in a glass nest, but most of the ants managed to escape, and the remainder died off[40]; in May, 1913, three females, with a packet of eggs, and twenty-eight workers were placed in a small well-fitting Crawley-Lubbock nest, the females rested in a small cell in the earth in the middle of the nest and the workers tunnelled long, narrow winding passages through the earth in all directions, small flies were dragged in and devoured, but the eggs disappeared, probably having also been eaten, and no more were observed to be laid, though the colony seemed in good condition and no deaths had occurred, when in August the nest was placed in a conservatory and the heat killed them all in one day.

Habitat.

Ponera punctatissima is found in isolated places in England, Germany, France, and Switzerland, and also in the Canary Isles[18]. Three subspecies occur in Madagascar and one on Laysan Island[19].

Hants, S. : Portsmouth (*Donisthorpe* and *Pool*)[20].

Kent, E. : Whitstable (*Chitty* and *Donisthorpe*)[14]; Deal (*Hall*)[16]; Queenborough (*Walker*)[17]; **Kent, W.** : Bromley (*Saunders*)[9]; Westerham (*Harwood*)[24].

Essex, N. : Colchester[13].

Middlesex : London, Burton Crescent (*Squire*)[4]; Hampstead Road (*Mrs. Varley*)[4]; Old Ford (*Bedwell*); Kentish Town (*O. E. Janson*); Zoological Gardens, Regent's Park (*Hodson*).

Oxford : Oxford (*Charsley*)[6].

Gloucester, W. : Minchinhampton (*Farren-White*)[11].

Glamorgan : Penarth (*Hallett*).

Yorks : York (*Britten*).

Cumberland : Nunwick, Great Salkeld (*Britten*).

Edinburgh : Edinburgh (*Stewart*)[15].

This species was first captured in Britain by Henry Squire in a bake-house near Burton Crescent[4], where it was again found by Stokes in 1860[4], and several specimens were also taken by Mrs. Varley in the kitchen of her house in Robert Street, Hampstead Road[4]. Charsley next discovered it in a conservatory at Oxford in June, 1877[6], and subsequently described it, as a new species, under the name of *P. tarda*, on account of its slow movements[7]. The ants were found in the earth of a bed in the conservatory, a species of *Myrmica* inhabiting the same bed, and living in perfect harmony with the *Ponera*. It is probable that the *Myrmica* referred to was *Tetramorium guineense* F., a species frequently found in hot-houses. The *Ponera* had evidently been long established in this conservatory, as wings and other parts of the insects were found among the dust on ledges which had not been disturbed for years.

It appears to frequent hot-houses, and bake-houses, having occurred in the former at Oxford, Minchinhampton—where a large colony was discovered in Mrs. Frith's hot-house by Farren White[11]—and Edinburgh—where Stewart found a colony in the Royal Botanic Gardens in a propagating frame, the heat of which was about 85° Fahr.[15]; and in the latter in London[4], Colchester[13], and Portsmouth[20].

It has also occurred away from houses and buildings :—Saunders took a winged female at some distance from any houses at Bromley[9]; Chitty and I found a deälated female and worker in flood refuse at Whitstable[14]; Walker captured workers in the bone-heap at Queenborough[17]; and Hallett swept up a deälated female on

June 20th, 1914, within half a mile of Penarth, on mixed herbage at the edge of a field. He tells me this field is about a quarter of a mile, as the crow flies, from the " tip " where the dustmen empty the town refuse. In 1921 P. Harwood sent several winged females and workers to me to name. He captured two workers in fungi, and a winged female which he beat off a fungus on October 29th in the Limpsfield Woods near Westerham. On November 5th he took twelve more specimens, including winged females as well as workers, in the same locality, in a sawdust heap on which some large fungi were growing. In this locality no houses are anywhere near, nor is there a refuse heap, or anything to suggest the ants had been introduced[24].

Its colonies are much more populous than those of *P. coarctata*, and the winged females, which occur in July and August, are produced in considerable numbers.

At the end of July, 1910, Pool sent me some winged females which he said were swarming in a scullery at Portsmouth, and in August we visited this scullery together, when the ants were still present in numbers, and this went on for several weeks, these females being chiefly found on a window facing the street. The scullery was connected with a bake-house by a grating and on visiting this a few winged females were also found there. The ants probably emerged from a hole in the masonry of one of the walls, though much search failed to find the nest, and no workers or males were taken. The baker said he had sometimes noticed small ants, crawling about and on the sugar for iceing cakes, some of which may have been the workers, but in the latter case they were probably *Monomorium pharaonis* L., the " house ant."

Charsley says that the females appeared in June[7], and Saunders took his winged female when sweeping in a wood on the evening of July 1st, 1886[9]. Britten captured a male, winged females and workers in a hot-house in Cumberland on April 7th, 1913; and Bedwell took a winged female in the Queenborough Chemical Works on October 3rd, 1914.

Roger found it commonly in Berlin under flower-pots on the borders in pine-apple houses, a colony often consisting of 30, 40, or 50 individuals, which left their nest and came out and ran about in the sunshine[1]. Blöte records it from the hot-houses in the Botanic Gardens at Leiden[26].

Forel discovered at Vaux in Switzerland a large colony in an old wall near a stable (no hot-houses being anywhere near), from which on August 16th, 1868, large numbers of winged females were taking flight. The females were unattended by workers, but he found males and workers in the interstices of the masonry of the wall[5].

The male of this species is always apterous; the description of the winged form given by Saunders[12] is probably taken from Forel, or André, which, as pointed out by Emery[18], refers to *P. eduardi*

Forel, a species not known to occur in Britain. Saunders says he has seen specimens of the apterous form (the true male of *P. punctatissima*) from Oxford, and I discovered a male, from Oxford, doing duty as a worker in the general collection of ants in the British Museum, this I transferred to the British Collection[22]. H. Britten, junior, captured a male with numerous workers on September 23rd, 1925, in Rowntree's Tropical House, York.

My description is made from a male taken by Britten in a hot-house at Great Salkeld in Cumberland.

Ponera punctatissima Roger, var. **exacta** Santschi.

Ponera punctatissima Santschi [nec Roger] Bol. Real. Soc. Espanola H. N. 21 165 (1921)[1]. *Ponera punctatissima* v. *exacta* Santschi Bol. Real. Soc. Espanola H. N. 23 133 (1925)[2].

☿ Differs from the type in that the scape of the antennae reaches the posterior border of the head.

In 1921 Santschi redescribed[1] and figured[1] the worker of *Ponera punctatissima* Roger, for which proceeding he gave the following explanation :—

" In August, 1920, he captured some 17 ☿☿ of a *Ponera* at Hammamet, Tunisia, at the bottom of an old well, which was damp but without water. These were identical with a specimen taken by Théry at Rabat in Morocco, and an example in his collection from Jyvöskylä (Sahlberg) received from Forel. On referring to the descriptions and figures of *P. punctatissima* given by Emery and Bondroit, he found that they appeared to have a much shorter scape to the antennae than that of his examples, and he therefore came to the conclusion that he had discovered a new species. He sent a specimen to Emery, who identified it with *P. punctatissima* Rog. He next sent an example to Berland of the Paris Museum to compare with the specimens in the André Collection, as he thought the type might be there. (Roger's type, however, as pointed out by me, is in the museum at Berlin.) Berland sent him a sketch of the head of the supposed type and told him that : (1) The scape reaches the posterior border of the head ; (2) the frontal furrow is broad to nearly the middle of the head, and then continues in a fine line which reaches the posterior border. Being fresher, his example was somewhat lighter in colour than the supposed type, but otherwise agreed with it in all particulars. Santschi therefore considered it was necessary to correct the figures and descriptions of *P. punctatissima*, which give it too short a scape and does not mention the frontal furrow. This last character easily separates it from both *P. coarctata* Latr. and *P. eduardi* Forel. In his figure he shows the thorax and petiole in profile ; the thorax and abdomen from above ; and the labial and maxillary palpi. Emery, in his ants of the Palaearctic Region, figures the head of the worker with the scape not reaching the posterior border of the head. In his table he distin-

uishes *coarctata, japonica, eduardi,* and *punctatissima* from *abeillei* nd *ragusai,* by the mesonotum being separated from the pleura y a suture (Santschi does not show this suture in his profile figure f *punctatissima* though he does for *coarctata* v. *atlantis*); and *unctatissima* from *eduardi* by the scape not reaching the posterior order of the head.

After I had seen Santschi's paper, I proceeded to overhaul all ie specimens of *P. punctatissima* I could get hold of in Britain. 'hese were from Edinburgh, Oxford; Old Ford, London; 'romley, Westerham, Chatham, Queenborough, Southsea, Gibaltar, and St. Helena. The specimens from Oxford included the ype of *P. tarda* Charsley, about which species Er. André wrote ı 1881 :—" M. Charsley d'Oxford a décrit, sous le nom *P. tarda,* ne espèce trouvée en Angleterre et qui n'est autre que la *P. punctatissima* aussi que j'ai pu m'en assurer par l'examen d'exemplaires , ♀ et ♂ ☿ qu'a bien voula me communiquer l'auteur."

To ascertain whether the scape reached the posterior border of ie head, I did not trust to measurements, but in every case I bent ie scape back right over the head. This can be done without any anger to the specimen if the antenna be first damped with a paintrush dipped in water or, better still, in wood-naptha. In all cases ie scape did not reach the posterior border of the head; with the xception of the specimens from Queenborough.

Subsequently Santschi wrote to Berlin and Stitz informed him iat in Roger's type of *Ponera punctatissima* the scape does not each the posterior border of the head. Santschi then proposed the ame *Ponera punctatissima* Rog. var. **exacta** n. var. (=*Ponera punctassima* Sants. 1921 *nec* Roger) for the soi-disant type of the André ollection, and the specimens from Hammamet (Santschi); Queenorough (Donisthorpe and Bedwell); Maroc, Rabat (Théry); and yvöskylä (Sahlberg). He pointed out that they were not individal variations, but that all the specimens from the same nest varied ı the same way; and that it now remains to find out if these ifferent forms possess ergatoid males, and other sexual distinctions[2].

Subfamily **Myrmicinae** Mayr.

The subfamily *Myrmicinae* is divided into ten tribes containing large number of genera, the majority of which are cosmoolitan. The workers all possess a sting, and the pupae are always aked. Nine genera occur in Britain, which may be distinguished s follows :—

Table of the Genera.

☿

1	No ☿ exists	3 *Anergates* Forel.
	☿ exists	2
2	Antennae 10-jointed	5 *Solenopsis* Westwood.
	Antennae more than ten-jointed	3

3	Petiole quadrangular	1 *Myrmecina* Curtis.
(2)	Petiole not quadrangular — — — — — — — — — — — — — — —	4
4	Post-petiole with a spine beneath	2 *Formicoxenus* Mayr.
(3)	Post-petiole without spine beneath — — — — — — — — — — — —	5
5	Epinotum unarmed	4 *Monomorium* Mayr.
(4)	Epinotum armed with two spines — — — — — — — — — — — — — —	6
6	The three last joints of the funiculus together much shorter than the rest	6 *Myrmica* Latr.
(5)	Not much shorter than the rest — — — — — — — — — — — — — — —	7
7	Eyes small, point-like	7 *Stenamma* Westwood.
(6)	Eyes normal, outstanding — — — — — — — — — — — — — — — —	8
8	Shoulders angled	9 *Tetramorium* Mayr.
(7)	Shoulders rounded — — — — — — — — — — — — — — — — —	8 *Leptothorax* Mayr.

♀

1	Gaster with a broad longitudinal channel	*Anergates* Forel.
–	Gaster without channel — — — — — — — — — — — — — — — — — —	2
2	Club of antennae large, two-jointed	*Solenopsis* Westwood.
(1)	Club of antennae not two-jointed — — — — — — — — — — — — — —	3
3	Epinotum unarmed	*Monomorium* Mayr.
(2)	Epinotum armed —	4
4	Post-petiole furnished with a spine beneath . . .	*Formicoxenus* Mayr.
(3)	Post-petiole without spine beneath — — — — — — — — — — — — —	5
5	Petiole quadrangular — — — — — — — — — — — — — — — — —	*Myrmecina* Curtis.
(4)	Petiole not quadrangular — — — — — — — — — — — — — — — — — —	6
6	Petiole very long	*Stenamma* Westwood.
(5)	Petiole not long —	7
7	Hairs not pointed at apex	*Leptothorax* Mayr.
(6)	Hairs pointed at apex — — — — — — — — — — — — — — — — — — —	8
8	Spurs simple ; size very large in proportion to the ☿ .	*Tetramorium* Mayr.
(7)	Spurs pectinate ; size not very large in proportion to the ☿ —	*Myrmica* Latr.

♂

1	Apterous	2
–	Winged —	3
2	The two joints of the pedicel very large, aspect immature	*Anergates* Forel.
(1)	The two joints of the pedicel not large, aspect normal —	*Formicoxenus* Mayr.
3	Antennae ten-jointed	*Tetramorium* Mayr.
(1)	Antennae more than ten-jointed — — — — — — — — — — — — — — —	4
4	Fore-wings with cubital cell half divided by a transverse nervure	*Myrmica* Latreille.
(3)	Fore-wings otherwise —	5
5	Mesonotum without Mayrian furrows	6
(4)	Mesonotum with Mayrian furrows — — — — — — — — — — — — — — —	7
6	Cubitus connected with radius at external border of first cubital	*Monomorium* Mayr.
(5)	Cubitus not connected with radius at external border of first cubital —	*Solenopsis* Westwood.
7	Wings very dark	*Myrmecina* Curtis.
(5)	Wings not very dark —	8
8	Frontal area distinct	*Stenamma* Westwood.
(7)	Frontal area not distinct — — — — — — — — — — — — —	*Leptothorax* Mayr.

MYRMECINA Curtis.

(μύρμηξ, ant.)

Type : Formica graminicola Latr. (=*latreillei* Curt. ; Curt., 1829).

The genus *Myrmecina* comprises very few species which range over the Palaearctic and Indo-Malayan regions.

☿ *Head* somewhat square, widely but not deeply emarginate at the base, posterior angles rounded ; *clypeus* short with two longitudinal carinae, and two blunt teeth in front ; *mandibles* broad, with two rather strong teeth and a number of smaller ones, when closed a triangular free space is left between them and the clypeus ; *maxillary palpi* four-jointed ; *labial palpi* three-jointed ; *antennae* twelve-jointed, with a three-jointed club ; *eyes* small, situated in front. *Thorax* short, broad in front, narrowed behind ; *epinotum* furnished with two strong spines, preceded by two small blunt teeth. *Petiole* quadrangular, longer than broad, the front part cut out and sloping *post-petiole* subtransverse and subquadrate ; *gaster* oval with very long first segment ; *sting* very small.

♀ Very like the ☿ ; *head* broader ; *mandibles* larger in proportion. *Thorax : epinotal spines* more robust. *Wings* blackish ; *fore-wings* with one radial and one cubital cell.

♂ *Head* globose, much smaller proportionately than in the ☿ and ♀ ; *mandibles* tridentate, narrow, hidden beneath the labrum ; *antennae* thirteen-jointed ; *scape* about as long as the two succeeding joints of the antennae taken together. *Thorax* high, with the Mayrian furrows on the mesonotum, and impression in front of the scutellum, distinct and crenate, *epinotum* bidentate. *Wings* as in the ♀. *Pedicel* and *gaster* much as in the ☿.

Original description [Curtis Brit. Entom. **6** 265 (1829)] :—

" Type of the Genus *Myrmecina Latreillii* Nob.

Myrmecina Nobis.

Antennae inserted in the middle of the face, remote, longer than the head and thorax, geniculated, hairy ; thirteen-jointed, basal joint short, but twice as long as the second, which is subglobose, the third and following oblong, those beyond the fifth being rather obovate-truncate, terminal joint the longest, elongate-conic. Labrum large and exserted, coriaceous, dilated at the base, each side producing a small lobe beneath ; anterior margin rounded and notched with a few bristles and ciliated.

Mandibles none, at least in the male.

Maxillae large and dilated, terminated by a broad membranous and ciliated lobe, meeting behind the mentum when at rest. Palpi rather long and slender, four-jointed, basal joint the smallest, second and third of nearly equal length, fourth long subfusiform.

Mentum subovate, truncated at the base, with an arched suture towards the top. Lip none ? Palpi rather long and slender triarticulate, first and second joints nearly of equal length, the third longer and subfusiform.

Head subglobose. Eyes globose. Ocelli very prominent, forming a large triangle. Thorax ovate. Metathorax bidentate. Peduncle biarticulate, second joint the largest and globose. Abdomen ovate-conic, five-jointed, basal joint covering the greater portion of the body. Wings with a trigonate stigma, the marginal cell pedicled at the apex ; one discoidal cell, and the apical nervures obscure. Legs rather long. Thighs long, slender, dilated in the middle. Tibiae short, anterior producing a pectinated spine. Tarsi five-jointed, basal joint as long as the tibia, the remainder oblong. Claws small, pulvilli distinct.

Obs. All the figures and description were taken from a male."

MYRMECINA GRAMINICOLA Latr.

graminicola Latr. ♂ (*nec* ☿, ♀); =*latreillii* Curt. ♂ ♀[24] (*latreillei* Forel). *Formica graminicola* Latreille Hist. Nat. Fourmis 256 (1802)[1]. *Myrmecina latreillii* Curtis Brit. Ent. 6 265 (1829)[2]; [Jenyns MS. Cat. Cambs. Ins. 2 31 (1843)][3]; Stephens Zool. 1 30 (1843)[4]. *Myrmica striatula* Nylander Acta Soc. Sc. Fenn. 3 40 (1849)[5]. *Myrmica bidens* Förster Hym. Stud. 1 50 (1850)[6]. *Myrmecina latreillii* Curtis Trans. Linn. Soc. Lond. 21 219 (1854)[7]; F. Smith Trans. Ent. Soc. Lond. (n.s.) 3 133 (1855)[8]: Cat. Brit. Foss. Hym. 36 (1858)[9]: Ent. Ann. **1860** 92[10]: **1866** 128[11]. *Myrmecina latreillei* Forel Denkschr. Schweiz. Ges. Nafurw. 26 73[12], 352[13] (1874). † *Myrmicisa latreillii* Capron Entom. 11 27 (1878)[14]. *Myrmecina latreillei* Saunders Trans. Ent. Soc. Lond. **1880** 222[15]; Dale Ent. Mo. Mag. 17 236 (1881)[16]; Capron Ent. Mo. Mag. 22 229 (1886)[17]; Swale Ent. Mo. Mag. 27 24 (1891)[18]; Wasmann zusam. Nest. gemischt. Kolon. Ameisen 176 (1891)[19]; Dalla Torre Cat. Hym. 7 61 (1893)[20]; Richardson Ent. Mo. Mag. 30 213 (1894)[21]; Farren-White Ants' Ways 247 (1895)[22]; Saunders Hym.-Acul. 32 (1896)[23]. *Myrmecina graminicola* Emery Öfv. Finsk. Vet. Soc. Förh. 40 130 (1898)[24]. *Myrmecina latreillei* E. A. Butler Ent. Mo. Mag. 35 290 (1899)[25]. *Myrmecina graminicola* Wheeler Amer. Nat. 35 519 (1901)[26]. *Myrmecina latreillei* Martineau Entom. 34 232 (1901)[27]; Chitty Ent. Mo. Mag. 38 74 (1902)[28]; Donisthorpe Ent. Rec. 14 16 (1902)[29]; Chitty Ent. Mo. Mag. 39 284 (1903)[30]; Jordain Trans. N.-Staff. Nat. Field Club 17 82 (1903)[31]; Vic. Hist. Somerset 1 75 (1906)[32]; Vic. Hist. Berks 1 76 (1906)[33]; Chitty Ent. Rec. 18 161 (1906)[34]: Ent. Mo. Mag. 42 212 (1906)[35]; Donisthorpe Trans. Leicester Lit.-Phil. Soc. 12 226 (1908)[36]: Ent. Rec. 21 258 (1909)[37]: 23 12 (1911)[38]. *Myrmecina graminicola* Donisthorpe Entom. 44 389 (1911)[39]; Ent. Rec. 24 4 (1912)[40]: 25 61 (1913)[41]; Crawley and Donisthorpe Int. Ent. Cong. Oxford (1912) 2 14 (1913)[42]; Emery R. Accad. Sci. Istit. Bologna **1916** 56–9[43]: Bull. Soc. Ent. Italiana 47 170 (1916)[44]; Donisthorpe Ent. Rec. 28 1–2 (1916)[45]: 29 30–31 (1917)[46]: 30 21 (1918)[47]: 31 1–2 (1919)[48]; Crawley Ent. Rec. 32 13 (1920)[49]; Donisthorpe Ent. Rec. 33 21 (1921)[50]; Emery Gen. Ins. 174 232 (1922)[51]; Donisthorpe Ent. Rec. 34 1, 81 (1922)[52]: 35 1–2 (1923)[53]: 36 49 (1924)[54]: 38 19 (1926)[55].

☿ *Blackish brown, hairy; head in front, mandibles, antennae, underside of the thorax and pedicel, the concave surface of the epinotum, and legs reddish—sometimes the sides of the thorax, the apex of the spines, and the basal half of the petiole and post-petiole are also reddish.*

Head longitudinally rugose; *scape* bent and curved, a little shorter than the rest of the antennae; the joints between the first joint of the funiculus and the first joint of the club strongly transverse, but gradually increasing in length and breadth, the first funicular joint being a little longer and broader than those immediately following. *Thorax* angled anteriorly,

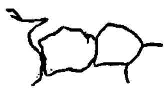


Fig. 57. Epinotum and pedicel of *Myrmecina graminicola* ☿.

strongly rugose longitudinally. *Gaster* black with apex reddish. *Long.* 3–3·6 mm.

♀ *Very like the* ☿ *but larger, and often with more red about the body. Wings* blackish and pilose. *Long.* 4–4·2 mm.

♂ *Black, smooth and shining, hairy. Head* triangularly raised between the eyes; *eyes* and *ocelli* *Wings* as in the ♀, but somewhat more pilose.

Petiole and *post-petiole* somewhat crenate at the base. *Legs* long, pitchy, with the femora dilated in the middle. *Long*, 3·4–4 mm.

Ovum : roundish, a little longer than broad, and white.

Larva : *mandibles* thin and pointed, reddish ; *head* long and narrow, bent over with the three thoracic somites, and the first abdominal, posteriorly towards the ventral surface ; the mesothoracic somite is prominent, projecting more forward than the other two somites. *Abdomen* pyriform, the first somite very prominent. The whole body is clothed with long, thin, curved hairs, mixed with shorter ones ; when young the larva is white, and the somites are not well defined posteriorly, but the full-grown larva is distinctly yellowish and all the somites are distinct.

Pupa : yellow, becoming the colour of the adult before emergence.

Original description of *Formica graminicola* Latreille. ♂ [Hist. Nat. Fourmis 256 (1802)] :—

" Le mâle ressemble aussi, pour le port, à celui de la fourmi rouge. Il est noir, luisant, pubescent. Les antennes sont d'un brun roussâtre clair avec le premier article noirâtre. La bouche est plus pâle. Le corcelet a deux petits tubercules aigus à son extrémité postérieure. Les pattes sont d'un brun clair, avec les cuisses et les jambes un peu plus foncées. Les ailes sont entièrement noirâtres, avec les nervures noires."

Original description of *Myrmecina latreillii* Curtis. ♂ [Brit. Ent. **6** 265 (1829)] :—

" Smooth, shining, piceous black ; sparingly clothed with hairs. Eyes black. Head and thorax with a few punctures. Antennae and legs ferruginous, thighs and tibiae piceous in the middle. Wings very iridescent, yellowish fuscous, stigma and nervures brown."

Original description of *Myrmecina latreillii* Curtis. ♀ [Trans. Linn. Soc. Lond. **21** 219 (1854)] :—

" *Female* black : head suborbicular-quadrate irregularly striated, clypeus bidentate ; eyes and ocelli minute, mouth ferruginous : mandibles large and prominent with many minute teeth ; neck distinct, ferruginous : antennae remote, not long, stoutish, geniculated, twelve-jointed and clavate, scape long, second joint cup-shaped, seven following transverse, the third being very short, the ninth much longer, the remainder forming a club, the apical joint being long and conical. Thorax not so large as the head, obovate, hollowed and striated before ; the scutel, which is smooth, has the suture at the base ferruginous ; post-scutel very short, punctate, with two short but distinct spines. Petiole ferruginous, elongated, hairy, basal nodule subquadrate or ovate, second broader, transverse, and partially striated : abdomen very smooth and shining, rather broad, slightly depressed and oval, the apex ferruginous. Wings fuscous, exactly like the male. Legs ferruginous, stoutish, especially the anterior, which are rather short : length 1⅔, expanse nearly 4 lines. Neuter undiscovered."

Habitat.

Myrmecina graminicola ranges over the whole of the Palaearctic Region, a variety occurring in Japan, and several subspecies in North America. In 1915 Forel gave the name of *Myrmecina kutteri* to an ant taken by H. Kutter at the foot of the Alps in Switzerland, but, as pointed out by Emery[42], this should only be

regarded as an aberration of *M. graminicola*. (I sincerely trust it will never become a recognized practice to name aberrations in ants ! Of course, it was not intended in this case, but should such a fashion arise it would encumber our nomenclature with names without end.)

The British distribution is as follows :—

Cornwall, E. : Fowey (*Dale*)[23] ; Rame Head (*Donisthorpe*)[37].

Devon, S. : Tavistock (*Swale*)[18] ; Cann Quarry, Plymouth (*Bignell*)[23] ; Virtuous Lady Mine (*Donisthorpe*)[37] ; Shaldon (*Rothney Coll.*) ; Seaton (*Crawley*) ; **Devon, N.** : Ilfracombe and Bideford (*Saunders*)[23].

Somerset, N. : Batheaston[32].

Dorset : Lulworth Cove (*Curtis*)[7] ; Portland[23], Charmouth[23], and Cranbourne (*Dale*)[23] ; Wareham and Lyme Regis (*Dale Coll.*) ; Weymouth (*Richardson*)[21] ; Swanage (*Nevinson*) ; Bloxworth (*O. P. Cambridge*).

Isle of Wight : Blackgang Chine (*Curtis*)[7] ; Luccombe and Shanklin (*F. Smith*)[11] ; St. Helens[37] and Sandown (*Donisthorpe*)[41].

Hants, S. : Hurst Castle (*Dale*)[22] ; **Hants, N.** : Woodhay (*Harwood*).

Sussex, W. : Worthing (*Saunders*)[23] ; Findon (*Donisthorpe*)[47] ; Goodwood (*Harwood*) ; **Sussex, E.** : Lewes (*E. A. Butler*) ; Ditching (*Donisthorpe*)[37] ; Portslade (*O. E. Janson*).

Kent, E. : Sandgate (*Curtis*)[7] ; Charing[35], Doddington[28], and Huntingfield (*Chitty*)[30] ; Whitstable (*Chitty* and *Donisthorpe*)[34] ; **Kent, W.** : Greenwich (*Curtis*)[7] ; Down (*Avebury*)[23] ; Otford (*Harwood*).

Surrey : Guildford (*Stephens*)[4] ; Mickleham (*D. Sharp*)[11] ; Shere (*Capron*)[17] ; Gomshall (*E. A. Butler*)[25] ; Box Hill (*Donisthorpe*)[38].

Herts : Tring (*Donisthorpe*)[36] ; Harpenden (*Morris*).

Middlesex : Camden New Town and Colney Hatch (*F. Smith*)[8] ; Kentish Town (*F. Smith Coll.*) ; Kensington (*Crawley*)[49].

Berkshire : Bagley Wood (*Young*)[33] ; Bradfield (*Joy*)[36] ; Aldworth (*Harwood*) ; Windsor (*Donisthorpe*).

Oxford : Oddington (*Crawley*)[42] ; Bletchington (*Donisthorpe*).

Suffolk, E. : Southwold (*F. Smith*)[10].

Cambridge : Swaffham Bulbeck (*Jenyns*)[3].

Gloucester, W. : Stinchcombe Hill near Dursley and Stone House (*Farren-White*)[22] ; Selsby (*Martineau*)[27].

Stafford : Colwich[31] and Cannock Chase (*Martineau*)[31].

Glamorgan : Sully (*Hallett*).

This interesting little ant was first discovered in Britain about 1829 by Curtis, who wrote[2]—" The only specimens I have ever seen of this little insect were all males, which I swept off rushes the middle of August and beginning of September, at the back of the

Male, female, and worker of *Ponera coarctata.*

Male, female, and worker of *Ponera punctatissima.*

Male, female, and worker of *Myrmecina graminicola.*

Isle of Wight, where they were flying about." In August, 1836, Curtis[7] discovered the female at Lulworth Cove, and captured males in several other localities.

Stephens[4] records it from near Guildford in 1842 ; he does not mention the sex, but as Curtis had not then described the female and the worker was unknown, it almost certainly must have been a male. Smith[10] took a female at Southwold in August, 1859, and remarks how strange it was that no one finds the worker. In September, 1865, the first workers were taken in Britain by Dr. Sharp who found a nest at Mickelham. Smith[11] recorded this fact and gave a description of the worker. Since then it has been met with in a number of localities, chiefly in the South of England, and appears to range as far north as Staffordshire.

Emery[42] published some interesting notes on Polymorphism in *Myrmecina graminicola.* He found that macrergates occur, and that a complete transition exists between the normal worker and normal female.

The habits of this ant are subterranean ; it nests under stones, in stumps, and at the roots of trees. The colonies are generally small and, at least in this country, have not often been observed. Lord Avebury found a colony near Down[23], and Farren-White[22] records another which he met with under a stone at the foot of Stinchcombe Hill, near Dursley,—it contained a deälated female, many males, workers, and larvae of all sizes. Jordain[31] states that Martineau observed colonies in dead tree-stumps at Colwich. I have twice found a small colony in a hollow flint at Box Hill[38], a very small hole on the under side of the flint giving access to the cavity within—each contained a deälated female and a few workers and brood.

Isolated workers are more frequently met with, and both Richardson[21] and Farren-White[22] record the fact that they have captured specimens in the centre of half-eaten strawberries.

The males and winged females occur away from the nests in August, September, and October, when they may be swept off grass, rushes, and herbage generally. Forel[13] records the capture of an isolated winged female on Mont Tendre, but does not mention the date, and Crawley[42] found a deälated female wandering on the flag-stones in front of his house near Oxford in August.

It is probable that both these specimens were (after the marriage-flight) searching for suitable situations to found colonies—in the latter case the female had already removed her wings. They are probably capable of founding their colonies independently (i.e. without the assistance of workers), as certainly appeared to be the case in the two instances referred to above—the small colonies in the hollow flints.

Crawley observed what he describes as a marriage-flight of this ant in a back garden at Kensington on September 9th–11th, 1919.

Some 30 alate females emerged from a hole between the flagstones in the garden. Several climbed up some steps and attempted to fly; but no males nor workers were seen[49].

It is also a fact, however, that this ant frequently occurs in the nests of other species. Farren-White[22] found it in company with *Acanthomyops flavus* near Dursley, and my own records are as follows:—two workers in a nest of *A. niger* at Doddington in May, 1901[29]; a single worker with *Formica fusca* at Rame Head in April, 1909[37]; one worker with *A. flavus* in the Meavy Valley in April, 1909[37]; five workers in a nest of *A. niger* at St. Helens, Isle of Wight, in August, 1909[37]; one worker with *A. flavus* and three with *F. fusca* at Box Hill in April, 1911[40]; one worker with *A. flavus* at Sandown, Isle of Wight, in September, 1912[41]; a small incipient colony consisting of a deälated female and eight workers in a nest of *Myrmica scabrinodis* at Box Hill in September, 1912[41],—this colony was situated in a small chamber in the middle of the galleries of the *Myrmica* nest, which was under a stone; two deälated females and three workers with *A. flavus* at Bletchington in May, 1913; six workers—some carrying larvae—in a large colony of *A. mixtus* in the root of a tree-stump at Box Hill in May, 1913; and a single deälated female in a similar nest of the same ant in the same locality in September, 1913; again at Box Hill with *A. flavus* and *A. mixtus* in May, 1914; and with *Myrmica scabrinodis* v. *sabuleti* in June, 1915; with *M. scabrinodis* at Findon[47] in June, 1917; and with *F. fusca* at Box Hill in April, 1920, and May, 1923[54].

Forel[13] found a colony in Switzerland which had formed a nest by the side of a nest of *Formica rufa*, and again another connected with a nest of *Ponera coarctata*. Wasmann[19] mentions a colony in a hillock of *F. exsecta* at Feldkirch in Vorarlberg. Wheeler[26] also records the American subspecies—*americana* Emery, and its variety *brevispinosa* Emery, and also another subspecies from Texas (subsequently described by him as *texana*) as being frequently associated with other ants. It is therefore probable that the females sometimes seek the protection of another ants' nest to found their colonies.

This ant has been described as a cowardly species, but I should rather regard it as a lethargic ant, of retiring habits. It is true that when alarmed it rolls up into a ball, the head touching the tail, with the legs and antennae packed close to the body, and feigns death—since its integument is exceedingly hard, it is well protected against ants and other enemies in this position. I have found that the male and female, as well as the worker, make use of this mode of defence[40]. The workers will not tolerate the presence of strange ants of their own species, as instanced by the two colonies found in the flints before mentioned. These were put together in a small observation-nest, when the workers of the first colony taken attacked and killed the female and workers of the second colony

and appropriated their brood. I have found also that they will attack and kill ants of other species, and bite at and hold on to a paint brush or tweezers when presented to them ; they will eat a little honey, but prefer animal food, devouring the dead bodies of other ants, as well as killing and eating live ones and their brood, and other insects, especially small flies. The ants pass the winter in the larval state and are piled on each other in a heap by the workers. The latter feed the larvae by mouth, but also place cut-up bits of insects and other food on their bodies for them to eat. They pupate in May and attain the perfect state in June and July.

No Myrmecophiles are known to occur with this ant, though my old friend the late Arthur Chitty suggested that the Proctotrupid *Pseudisobrachium subcyaneum* Hal., was parasitic on it, as he frequently swept them up together. I have also taken a number of Proctotrupids in this way, with the males of the ant, some having black wings like the latter[41], but it is not certain that they are really associated. The ants do not appear either to keep, or attend, plant-lice or *Coccidae.*

Forel[12] states that this species has a faint raspberry-like smell, which is not, however, always noticeable ; this I have not been able to detect although I have kept a small colony under observation since 1910. The following extracts are from my notes :—

May 1st, 1910—a small colony consisting of a deälated female, a certain number of workers, eggs, and young larvae, was found in a hollow flint at Box Hill—these were taken home and established in a plaster observation-nest. May 8th—another smaller colony was taken in a hollow flint in the same locality, and placed with the first colony, but, as before stated, the latter attacked and killed them. July 10th—more eggs have been laid, and some pupae are present. July 20th—pupae very dark in colour. Ants emerged from all the pupae during August. September 29th—many larvae present in a heap in one corner of the nest, the female and workers resting on the heap. January 1st, 1911—all well, the larvae have not grown during the winter. April 1st—the larvae are larger. May 4th—some more very small larvae noticed. May 16th—fresh pupae. May 24th—a fresh bunch of eggs and more pupae. July 5th—a single male hatched. July 23rd—more eggs laid. July 27th—all pupae have come to maturity ; one worker has the antennae deformed (curled round like horns)[52]—it is a pugnacious little ant, but generally sits by itself away from the others. November 16th—over fifty larvae present—the colony passed the winter quietly and hardly any deaths occurred. June 1st, 1912—pupae again present. July 2nd—callows hatched, and fresh bunches of eggs carried by the workers. September 1st—some hundred workers present (reared during the two years). December 25th—seventy-three workers dead—the nest had been allowed to get too dry,

January 21st, 1913—the nest again in good condition—the queen and the remaining workers well, some eggs and many larvae of all sizes present. February 8th—the ants devour some packets of eggs of *Formica rufa* given to them. March 31st—the ants kill and cut up a half-drowned *F. rufa* worker given to them. May 6th—eggs very small, and nearly full-grown larvae present—no ants have died since February. June 16th—pupae present. July 10th—more pupae, some nearly adult in colour. September 1st—all pupae have hatched, many larvae present, only six dead ants. In 1914 a large number of workers were reared. July 1st, 1915—three winged females had just emerged from the pupae, by July 10th over fifty were present and others continued to appear up to the beginning of August. As this colony had been in my possession for over five years, these females must therefore have been produced from eggs laid in captivity ! August 9th—one male appeared. Copulation was not observed, but by the end of August a number of the females had removed their own wings. September 10th—the old queen (recognizable by the fact that she was not nearly so hairy nor pubescent as the young deälated females) was observed to bite at the male and drive him away. September 16th—male flying about in a very excited state in the two light chambers of the nest. September 20th—male dead. December 15th—the last winged female present removed her wings. The winged females help to carry about the larvae, and to kill and cut up flies, etc. The young deälated females behave exactly in the same manner as the workers[45]. April 27th, 1916—a cripple female with bent antennae and deformed wings present ; frequently dragged about by the old workers and deälated females, who removed her wings. May 3rd—cripple dead. May 7th—a perfect winged female emerged. May 12th—over a dozen present—quite fifty females were produced, sooner or later all removed their wings, the last with wings observed November 20th. May 20th—three males appeared. June 4th—eight males present—some fifteen in all being reared. It is probable that these males were produced from eggs laid by the 1915 virgin females, as at one time a number of small egg-masses were present among the larvae. The larvae are always spread out over the floor of one of the dark chambers, and the workers and deälated females rest upon them, the old queen's eggs being in the centre. Copulation took place between the males and females in the nest ; it being observed on June 23rd, 24th, 30th, July 8th, and 21st, all with winged females. In copulation the sexes are firmly fixed together for some hours at a time ; the males sometimes resting on the back of the female, and sometimes being dragged along on the ground behind her. August 30th—nearly all the males dead, and most of the females deälated. April 8th, 1917—female pupae present. May 18th—male, female, and worker pupae in plenty. June 2nd—first winged female. June 13th—first male hatched.

June 23rd—over twenty of each present. October 13th—only one winged female present; all males dead. The ants behaved much as in the previous year. December 31st—large number of medium-sized larvae, and numerous workers and deälated females resting on them. When I recorded the above facts[47], I stated as my opinion that—"Ants do not rear the winged forms until the colony has reached a certain strength, and sufficient workers have been produced; then, given abundant and suitable food, they will bring up the sexes. Having reached this stage, the ants are able to bring up the sexes (males may also be produced under certain circumstances from parthenogenetic eggs); and judging from my experiments I do not believe that the queen lays eggs which must become females, but that the workers bring this about by extra feeding of their larvae." May 27th, 1918—the first male appeared. June 30th—the first winged female. August 25th—only one female still retaining her wings. September 17th—a male trying to copulate with a dead worker; he persisted in his efforts for a considerable time. October 7th—the last male died. In 1918 winged females were produced in less numbers than in previous years; but males in greater. In August, 1919—very serious fighting occurred indiscriminately between workers and deälated females. One worker might be attacked by two others, or by two females, or by a worker and female, or by one worker alone, or one female; and the same with one female. This lasted for nearly two months, and I was much afraid I should lose the whole colony, as some one hundred ants were killed off in this way. It is very difficult to explain this, for the colony had plenty of food and a large brood to attend to. It was put a stop to in the end by punishing any ant, or ants, who were fighting. They were knocked off their legs with a paint-brush, pushed about, rolled over, and shaken about until they appeared to be thoroughly cowed!

In 1920 the colony had recovered and was in a flourishing condition; but no winged females were reared for the first time for four years. I believe that the fighting which occurred in 1919 was the cause of this. June 17th, 1921—the first winged females hatched. Large numbers of winged females were subsequently reared, and many males. November 15th—several females still retaining their wings. During the winter the ants kept very quiet and very few deaths occurred. Very little food of any kind was given to them. April 23rd, 1922—bits of raw beef were given; these were cut up by the ants and fed to the larvae: the latter having pellets of the meat placed on their bodies for them to chew at. May 2nd—a packet of eggs present. May 28th—several packets of eggs, and male, female and worker pupae present. Several female "Daddy-longlegs" given to the ants; their bodies were cut up and devoured, and numerous eggs, taken from them, fed to the larvae. June 11th—four winged females present. June 22nd—many eggs, very many winged females, and a few males present. July 9th—

the body of a " Magpie-moth " placed in the nest ; the ants would have nothing to do with it ! This shows how very distasteful the moth must be, as *Myrmecina* is so fond of an insectivorous diet, devouring greedily flies, earwigs, clothes-moths, and other ants, etc. October 29th—all the females had shed their wings, except one who retained a single wing. In 1922 many more winged females, and far fewer males were reared than in any single year previously. February 11th, 1923—first eggs laid. February 25th—female pupae present. April 22nd—winged female present. June 24th—two males and five winged females. September 30th—two large bunches of eggs in different parts of the chamber, surrounded by many workers and deälated females; many larvae, worker pupae, and several males still present. Very many males and winged females were reared in 1923. January 20th, 1924—all well, no dead ; fed ants with raw meat. February 3rd—fed ants with rose-gall grubs, which they greedily devoured. April 13th—three separate bunches of eggs present. May 26th—first males hatched. June 5th—first winged females. June 22nd—a male endeavoured to copulate with a deälated female. Many winged females and males were reared in 1924. In October the nest was placed in a cold room (and the ants were not fed again, the nest only being watered occasionally) until May, 1925. A number of males, but no winged females, were reared in 1925. July 12th, 1925—several males all trying to copulate with one deälated female ; three bunches of eggs present.

Having visited Sicily during the winter, the nest was again kept in a cold room, and without food, during my absence. Only males, no winged females, produced in 1926. June 30th—colony in good condition ; several bunches of eggs, and numerous worker larvae and pupae present.

The nest is still under observation. It will be seen that I have had this colony of ants in captivity for over fifteen years. It is much to be regretted that I did not think of marking the original queen in some way as, after winged females had been reared for several years, and having removed their wings had joined the other ants, it was impossible to recognize her again with certainty.

FORMICOXENUS Mayr.

(Formica, ant ; ξένος, guest.)

Type : **Myrmica nitidula** Nyl. (Mayr, 1855).

The genus *Formicoxenus* is confined to the temperate parts of the Palaearctic Region ; three species are known which are found in Europe, only one, *F. nitidulus* Nyl., occurring in Britain.

☿ *Head* oval ; *clypeus* large, triangular ; *frontal carinae* short, parallel, widely separated ; *frontal area* indistinct ; *mandibles* broadest at the extremity, with the terminal border dentate ; *maxillary palpi* four-jointed ;

labial palpi three-jointed ; *antennae* eleven-jointed, with a three-jointed club ; *eyes* moderate, situated at about the centre of the lateral borders of the head ; *ocelli* generally wanting, sometimes present. *Thorax* flat ; *epinotum* separated from the mesonotum by a distinct channel, and armed with two blunt teeth. *Petiole* angled above and below ; *post-petiole* armed beneath with a distinct spine ; *gaster* oval with very long first segment nearly covering the rest ; *sting* moderate.

♀ Very like the ☿ ; a little larger ; *fore-wings* with one cubital cell, and one discoidal cell, the radial cell being open.

♂ Ergatoid ; *antennae* twelve-jointed, with a four-jointed club.

Original description [Mayr Verh. Zool. Bot. Ver. Wien **5** 413 (1885)] :—

" *Formica* und ξένος Gast.

Arbeiter. Der glatte, glänzende Kopf ist länglich viereckig mit stark abgerundeten Ecken, länger als breit und breiter als der Thorax. Die Oberkiefer sind am Ende nicht viel breiter als am Grunde, deren Innenrand ist mit Zähnen besetzt. Die Unterkiefertaster sind viergliedrig. Die Lippentaster sind dreigliederig (scheinbar zweigliedrig), deren erstes Glied ist lang und dünn, das zweite und dritte sind nicht lang aber breit und können bei flüchtiger Untersuchung für ein einziges Glied gehalten werden. Die Oberlippe ist vorne abgerundet und in der Mitte des Vorderrandes schwach ausgebuchtet.

Der Clypeus ist gross, ungekielt, von einer Seite zur anderen ziemlich flach, von vorne nach hinten schwach convex. Das Stirnfeld ist kaum angedeutet. Die Geissel der eilfgliedrigen Fühler ist keulenförmig. Die Punctaugen sind bei den meisten Individuen vorhanden ; merkwürdiger Weise gibt es aber auch manche Exemplare, bei welchen man selbst bei der stärksten mikroscopischen Vergrösserung keine Andeutung von Punctaugen aufzufinden im Stande ist. Die mässig grossen, flachen Netzaugen stehen etwas hinter der Mitte des Kopfes. Der glatte und glänzende Thorax ist hinter dem Mesonotum nicht eingeschnürt, es ist bloss eine feine Furche, welche die Gränze zwischen dem Meso- und Metanotum bildet, vorhanden. Das Metanotum ist mit zwei horizontal stehenden, nach hinten gerichteten, dicken Zähnen bewaffnet. Das erste Glied des Stielchens ist vorne nicht stielförmig verlängert, es ist knotenförmig und verlängert sich nach oben in einen stumpfen Kegel, nach unten in einen dicken, starken und stumpfen Zahn ; das zweite Glied ist knotenförmig, etwas breiter als lang und an der Unterseite mit einem nach abwärts und vorne gerichteten Dorne versehen. Der Hinterleib ist mässig gross, oval ; das erste Segment bedeckt fast den ganzen Hinterleib.

Weibchen. Der Kopf mit seinen Theilen verhält sich ebenso wie beim ☿, doch sind die drei Punctaugen stets vorhanden. Das Mesonotum ist abgeflacht ; das Metanotum ist wie beim ☿ mit zwei Zähnen bewehrt, die Basalund abschüssige Fläche desselben sind nicht deutlich von einander abgegränzt. Das Stielchen ist so wie beim ☿, ebenso der Hinterleib. Die Costa transversa der Flügel verbindet sich mit der Costa cubitalis nahe an der Theilungsstelle der letzteren, wodurch nur eine geschlossene Cubitalzelle gebildet wird ; die Costa recurrens schliesst eine Discoidalzelle ab."

Formicoxenus nitidulus Nyl.

Myrmica nitidula Nylander Acta. Soc. Sc. Fenn. 2 1058 (1846)[1]. *Myrmica laeviuscula* Förster Hym. Stud. **1** 54 (1850)[2]. *Myrmica lucidula* F. Smith Ent. Ann. **1858** 39[3]. *Myrmica nitidula* F. Smith Ent. Ann. **1858** 40[4] : Proc. Ent. Soc. Lond. (n.s.) 4 1857 89 (1858)[5]. *Myrmica* (*Stenamma*) *westwoodii* F. Smith Trans. Ent. Soc. Lond. (n.s.) 4 1857 281 (1858)[6] : Cat. Brit. Foss.

Hym. 32 (1858)[7]. *Stenamma* (*Myrmica*) *westwoodii* F. Smith Ent. Ann. **1872** 98[8]. *Stenamma westwoodii* Forel Denkschr. Schweiz. Ges. Naturw. **26** 82[9] 227[10] (1874). *Stenamma westwoodii* Saunders Trans. Ent. Soc. Lond. **1880** 216[11]. *Formicoxenus nitidulus* Er. André Spec. Hym. Europe **2** 273 (1881)[12]; Saunders Ent. Mo. Mag. **20** 16 (1883)[13]; Adlerz Öfv. Kongl. Vet-Akad Förh. **41** 43–64 (1884)[14]; Forel Ann. Soc. Ent. Belg. **30** 135 (1886)[15]; Wasmann zusam. Nest. gemischt. Kolon. Ameisen 35 (1891)[16]; Dalla Torre Cat. Hym. **7** 62 (1893)[17]. *Stenamma westwoodii* Farren-White Ants' Ways 245 (1895)[18]; *Formicoxenus nitidulus* Saunders Hym.-Acul. 31 (1896)[19]; Janet Animaux Myr. 54–56 (1897)[20]; Vic. Hist. Worcester **1** 89 (1901)[21]; Donisthorpe Ent. Rec. **14** 15 (1902)[22]; Vic. Hist. Warwick **1** 73 (1904)[23]; Wasmann Arch. Trim. Inst. Grand-Ducal Luxemburg **1906** 17[24]; Donisthorpe Ent. Rec. **18** 317 (1906)[25]; Vic. Hist. Berks **1** 76 (1906)[26]; Bagnall Ent. Mo. Mag. **42** 140[27] 210[28] (1906); Emery Deutsch. Ent. Zeitscher. **1908** 551[29]; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 226 (1908)[30]; Arnold Ent. Mo. Mag. **45** 278 (1909)[31]; Wheeler Ants 430–431 (1910)[32]; Donisthorpe Ent. Rec. **25** 62 (1913)[33]: Rep. Lancs-Chesh. Ent. Soc. **36** 1912 53 (1913)[34]; Schmitz Jaar. Natuur. Genoots Limburg **1915** 130[35]; Emery Bull. Soc. Ent. Italiana **47** 190 (1916)[36]; Box Ent. Mo. Mag. **53** 17 (1917)[37]; Stumper Biol. Centralb. **38** 160–79 (1918)[38]: Bull. Soc. Nat. Luxembourg (1918)[39]: Bull. Soc. Ent. Belg. **3** 90–7 (1921)[40]; Emery Gen. Ins. **174** 265 (1922)[41]; Donisthorpe Ent. Rec. **35** 2 (1923)[42].

Fig. 58. Pedicel of *Formicoxenus. nitidulus* ☿.

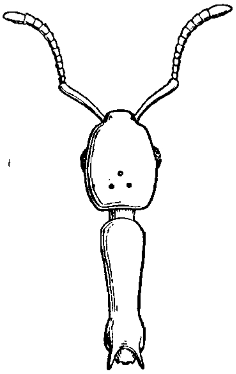


Fig. 59. Head and thorax of *Formicoxenus nitidulus* ♂.

☿ *Smooth and shining, reddish yellow, gaster reddish brown. Mandibles* meeting when closed. *Post-petiole* armed beneath with a small spine. *Long*, 2·8–3·4 mm.

♀ *Very like the* ☿, *a little larger, and darker in colour. Eyes* larger; *ocelli* present. *Post-petiole* as in the ☿. *Long*. 3·4–3·6 mm.

♂ *Very like the* ☿. *Mandibles* short, unarmed, not meeting when closed; *eyes* larger; *ocelli* always present; *antennal funiculi* more curved. *Post-petiole* as in ☿; *gaster* with one more segment. *Long*. 2·8–3 mm.

Original description of *Myrmica nitidula* Nylander [Acta. Soc. Sc. Fenn. **2** 1058 (1846)] :—

" ☿ laevis tota nitidissima nuda, rufa, abdomine fusco, oculis atris; antennae 12-articulatae; thorax supra convexiusculus longitudine abdominis (praeter petiolum), metathorax a mesothorace impressione trans-

versali discretus, metanoto in dentem validiusculum horizontalem utrinque exeunte; nodus petioli posterior antice infra spinulâ minutâ instructus. Corpus pilis nonnullis subtilissimis. Statura et magnitudo proxime *Myrmicae muscorum*. Ab omnibus congeneribus supra allatis abunde discedit haec species jam capite, thorace nodisque petioli politis, propriaeque referenda est subdivisioni Operarium in acervo formicae cujusdam rufae prope Helsingfors invenit ad determinandumque mutuam dedit Stud. F. W. Maeklin. Ex unico specimine notas ulteriores dare nequeo."

Habitat.

Formicoxenus nitidulus is found in North and Central Europe and West Siberia in the nests of *Formica rufa* and *pratensis*. Wasmann discovered a colony with the latter in Luxemburg, all the individuals being of a dark brown colour, to which he gave the varietal name of *picea*[24].

Isle of Wight : Parkhurst Forest (*Jeffery*)[42].

Hants, S. : New Forest (*G. R. Waterhouse*)[5]; Bournemouth (*Jackson*)[25].

Kent, E. : Blean Woods (*Chitty* and *Donisthorpe*)[22].

Surrey : Weybridge (*G. R. Waterhouse*)[5]; near Guildford (*Capron*)[18]; Shere (*Capron*)[19]; Guildford (*Smith*)[19]; Esher (*Champion*)[19]; Oxshott (*Bedwell*); Camberley (*Donisthorpe*).

Essex : Hockley (*Box*)[37].

Berkshire : Wellington College (*Barnes*)[26]; Tubney (*Collins*).

Worcester : Bewdley (*Blatch*)[21].

Warwick : Knowle (*Ellis*)[23].

Yorks, N.E. : Scarborough (*Lawson*)[8].

Yorks, S.W. : Grimesworth Dean (*Butterfield*).

Durham : Chopwell Woods (*Bagnall*)[30].

Northumberland, S. : Corbridge-on-Tyne and Hexham (*Bagnall*)[27].

Westmorland and L. Lancs : Grange-on-Sands (*Bagnall*).

Cumberland : Keswick (*Day*).

Aberdeen, S. : Bridge of Gairn (*King*).

Easterness : Nethy Bridge (*Donisthorpe*)[33].

This small ant was added to the British list in 1857, by G. R. Waterhouse[5], who took specimens in the nests of *Formica rufa* at Weybridge, and in the New Forest. It is a myrmecophilous species only occurring in the nests of its hosts *F. rufa* and *pratensis*, though Wheeler[32] (p. 434) suggests that it may once have been a guest of *Myrmica rubida* (as *Symmyrmica chamberlini* Wheeler, an archaic form of *Formicoxenus* found in Utah, lives with *Myrmica mutica*, a species closely related to *M. rubida*) and only later became attached to *Formica rufa*. He goes on to say :—" This is suggested by the fact that the present host belongs to a different subfamily and by the extreme ergatomorphism of the males. This specialization is, at any rate, an interesting example of the more advanced state of development of European as compared with North

American species belonging to the same or allied genera." However this may be, *M. rubida* is not found in Britain, whereas *F. nitidulus,* as shown above, is widely distributed here, but of course it is possible that the former may have inhabited Britain at some far distant period. The nest of *F. nitidulus* is small and is constructed from the finer materials of which the hosts' nest is composed ; it is generally situated in the interior—more rarely in the upper surface of the hillock—small galleries connecting it freely with its surroundings. Adlerz[14] found a colony in Sweden situated in the cracks of a rotten oak-stump, over which the host species had built their hillock.

Wasmann[16] discovered in Holland a small colony, consisting of workers, males, females, and brood, situated in an old cocoon of *Cetonia floricola,* a beetle which passes its early stages in the nests of *F. rufa* and *pratensis.*

Its colonies are small, not consisting of more than a hundred individuals, and it is not known how a new colony is founded. The male is apterous, mating taking place on the surface of the nest, and I have suggested that after fecundation the females fly away to other *rufa* nests to lay their eggs, but some probably re-enter their own nest[34].

The presence of *Formicoxenus* in the nests of its hosts may no doubt be explained by the fact that it thus obtains safety from enemies, shelter and warmth in which to rear its brood, and also sustenance, though, as Wheeler[32] remarks, " the nature of its food remains an enigma." It has never been observed to be fed by its hosts, nor to devour the brood of the latter, or their prey—I have noticed they will eat honey, and also the larvae of *Leptothorax acervorum*[34], and this latter fact is interesting, as Er. Andre described another species of *Formicoxenus* (*F. ravouxi*), taken by him in the south of France in a nest of *Leptothorax unifasciatus* (*vide* Bull. Soc. Ent. France **1896** 367). Colonies of *L. acervorum* are frequently found in the nests of *F. rufa,* but it is not suggested that the larvae of the former are the only or proper food of *Formicoxenus.*

Stumper, who has written several papers exclusively on this ant, considers that its food consists partly of the rain water which filtrates through the domes of the nests of its hosts, such water being charged with nutritive salts, etc.[38 39 40].

The relationship between guests and hosts is obscure ; the *Formicoxenus* moves freely about among the *Formica,* but is generally treated with indifference ; the latter sometimes threatening with their jaws, but never actually attacking them. When *nitidulus* meets a *rufa* it crouches down and remains motionless, and the *rufa* generally passes on, though sometimes the host may tap its guest with the antennae.

When the hosts move to another nest, their little guests follow

them carrying their fellows and their brood; an interesting instance of this was observed by Forel[15] in Switzerland. Having several times disturbed a nest of *Formica pratensis* (which also contained *Formicoxenus*), the ants deserted it and moved away to an old nest situated at a distance of fourteen metres—on August 13th he noticed *F. nitidulus* following, in files, in the track of the *F. pratensis*, carrying their winged females, workers, and brood, and not experiencing any difficulty in finding the way.

When a *Formicoxenus* carries another worker, it holds the latter, not (as a *Formica* would) under its body, but (as other *Myrmicinae* do) over its back.

Nylander[1] described *F. nitidulus* so long ago as 1846, but the male remained unknown until 1884 when it was discovered by Adlerz[14] in Sweden. This sex was not recorded from Britain till 1906, when Bagnall[28] captured some ten examples in nests of *F. rufa* at Corbridge-on-Tyne on August 12th, and in July and August, 1910, more males were taken by Arnold[31] and Hamm, from what was evidently a large colony, in a *rufa* nest in the New Forest (there is, however, an unrecognized male in the Rothney Collection at Oxford, doing duty as a worker of *Stenamma westwoodi*—this was taken by Dr. Power at Weybridge on July 24th, 1864[34]). On September 6th, 1912, I secured a number of males from a nest of *F. rufa* at Weybridge[33], in which *Formicoxenus* had occurred for many years past. The day was dull and cloudy, and the males were observed running about on the surface of the *rufa* nest; they were easily distinguished from their own workers, by their more active and restless habits, and the bent funiculi of the antennae. These males endeavoured to copulate with the deälated females, and also with the workers, climbing on to their backs and grasping them round the thorax with their short mandibles, both on the surface of the nest and in my tubes—on September 14th six more males were found in this nest[34]. Wheeler[32] describes the mating of this species, which he observed in the Upper Engadine in July, 1907, as follows:—

" After a cold night, the sun remained behind a mass of clouds at about 9 a.m., when I saw dozens of *Formicoxeni* of all three phases, but mostly males, running hither and thither over the small twigs and other debris forming the outer covering of an old *rufa* nest which I had stopped to examine. The males moved very quickly, with feverishly vibrating antennae, and were so amorous that they often seized workers and attempted to mate with them. The few winged females were soon supplied with partners and the supernumerary males continued to hurry about over and among the little sticks of the nest. Then the sun suddenly emerged from the clouds and, as if by magic, all the *Formicoxeni* disappeared into the nest. I waited for some time and during the remainder of the

morning returned repeatedly to the spot, but none of the tiny inquilines reappeared."

In July, 1915, J. F. X. King captured a number of males and winged females in *F. rufa* nests at Bridge of Gairn.

It will thus be seen that the males may be found in July, August, and September, and the winged females in July and August—(I have only once taken the winged female—in August, 1906, at Bournemouth).

As I have mentioned in my description of the genus of this ant, the worker sometimes possesses ocelli; in fact, polymorphism is very evident, and a complete transition exists between the normal worker and the normal female. This is very well illustrated by Stumper[40].

The following notes on a small community kept in captivity may be of interest :—

September 14th, 1912—a number of workers, several deälated females, and six males, taken in a *rufa* nest at Weybridge, were established in a plaster nest. September 15th—several workers attacked each other, some being dragged about by the legs and antennae—this occurred at intervals till September 24th. September 20th—two males have died; all the ants crowd round some honey, and simultaneously tap on the ground (when probably stridulating) whilst devouring it; larvae of *Leptothorax acervorum* taken in the same *rufa* nest, also eaten. September 24th—a few workers dead; some fifty left. September 30th—all the males now dead. October 3rd—introduced a *rufa* worker, it paid little attention to the *Formicoxeni*, but eventually picked up one and carried it a little way, setting it down again unhurt; fresh honey being introduced, the *rufa* went to feed at it, when the little ants crept under it and between its legs to get at the honey; the *rufa* moved its legs uneasily when the little ants touched against them. November 1st—as the *rufa* took no further notice of its companions it was put back into its own nest; more *Leptothorax* larvae introduced, these were collected together into a heap and rested on by the *Formicoxeni*. December 1st—no deaths have occurred since September 30th; the *Leptothorax* larvae appear to be treated as if they were the brood of their hosts. December 30th—a few eggs have been laid and placed on the *Leptothorax* larvae. January 21st, 1913—a few young larvae present among the *Leptothorax* larvae. February 8th—introduced a small packet of *rufa* eggs; these were never touched, and eventually went mouldy. May 1st—all the larvae have disappeared, probably eaten. May 6th—introduced some larvae of *Leptothorax affinis* (from my nest which was taken at Yvorne, Switzerland), these were collected into a heap as before. June 1st—only one deälated female and six workers present, resting on the *Leptothorax* larvae; the glass cover of the nest not fitting closely, many must have escaped. July 8th—on my return home,

all the ants were found to have disappeared. These little ants were thus kept in captivity, away from their hosts, for some ten months, and had they not unfortunately escaped, would probably have existed for a much longer period.

ANERGATES Forel.

(ἀ, negative prefix ; εργάτης, worker.)

Type : **Myrmica atratula** Schenck (Forel, 1874).

This extraordinary genus, which is confined to the temperate parts of the Palaearctic Region, only possesses one species, in which the worker phase is absent.

♀ *Head* strongly emarginate posteriorly ; *clypeus* rounded posteriorly, deeply cut-out anteriorly ; *mandibles* moderate, terminal border short, and furnished with one tooth at the extremity ; *maxillary palpi* two-jointed ; *labial palpi* one-jointed ; *antennae* eleven-jointed, *scape* cylindrical, broadest anteriorly, *funiculus* with first joint long, third very short, those following gradually increasing in length, last joint as long as the two preceding taken together, *club* indistinct, composed of the last three or four joints ; *eyes* large, situated in the centre of the lateral borders of the head ; *ocelli* moderate. *Thorax* short ; *epinotum* furnished with two distinct tubercles. *Fore-wings* with one cubital cell, no discoidal cell, and radial cell open. *Petiole* transverse, thick ; *post-petiole* twice as broad as long, soldered to the first segment of the gaster ; *sting* wanting, or rudimentary. *Legs* without spurs on the intermediate and posterior pairs.

♂ *Head* less deeply emarginate posteriorly ; *clypeus* as in the ♀, but less deeply cut out ; *mandibles* narrow, rounded, not distinctly toothed ; *maxillary* and *labial palpi* as in the ♀ ; antennae eleven-jointed, but shorter and broader than in the ♀. *Thorax* composed of the usual sclerites possessed by winged male ants ; *pronotum* short ; *mesonotum* without Mayrian furrows ; a tubercle takes the place of the articulation of the fore-wings. *Petiole* and *post-petiole* short, very broad and resembling segments of the gaster ; *gaster* broad, thick and strongly bent beneath the body, convex above, and concave beneath ; *genital organs* large, prominent.

Original description [Forel Denkschr. Schweiz. Ges. Naturw. **26** 93 (1874)] :—

" *Genus* **Anergates** *nov. genus.*

(*α sine* ; *ἐργατης operarius.*)

Operaria : *Deest.*

Femina : Petioli articulus primus crassus, obtusus, latior quam longior ; secundus antice convexus, duplo latior quam longior, abdominis segmento primo coalitus. Caput postice valide emarginatum. Palpi maxillares 2, labiales 1 articulati ; palporum articuli breves et crassi. Antennae 11 articulatae ; scapus cylindricus ; flageli articulus primus longus, secundus brevior, tertius brevissimus ; articuli sequentes sensim usque ad apicem in longitudinem et latitudinem crescunt ; articulus ultimus duos praecedentes una sumptos longitudine aequat. Mandibulae haud latae, margine terminali brevi, acuto, apice cum dente uno. Clypeus postice rotundatus, antice in medio usque ad marginem posteriorem profunde lateque excavatus. Clypei partes laterales longitrorsum nequaquam angustatae, ut fieri solet. Laminae frontales breves, elevatae, vix divergentes. Area frontalis et sulcus frontalis variabiles. Oculi ad media capitis latera. Fossa antennalis profunda. Alae superiores cellula cubitali una, discoïdali nulla ; costa transversa cum costa

cubitali, vel cum ramo cubitali externo conjuncta. Cellula radialis aperta. Metanotum tuberculis elevatis duobus. Pedes non longi. Aculeus inchoatus aut nullus. Pedes medii et posteriores sine calcaribus.

Mas. Allae nullae. Palpi, oculi, ocelli, laminae frontales et fossa antennalis ut in ♀. Clypeus ut in ♀, sed excavatione paulo minus profunda. Caput etiam paulo minus postice emarginatum. Area frontalis et sulcus frontalis variabilia. Mandibulae haud latae, ad apicem rotundatae, sine dente et sine margine terminali distincto. Antennae 11 articulatae ut in ♀, sed breviores et crassiores. Thorax ut in maribus alatis, pronoto brevi, scutello, proscutello et postscutello praeditus. Locus alarum superiorum articulationum protuberantia signatus est. Mesonotum sine sulcis convergentibus. Metanotum in medio paulo concavum, sed absque tuberculis. Pedes breves, crassi. Petioli articuli ambo breves, latissimi, abdominis segmentis simillimi. Abdomen maximum, crassum, infra ita incurvum ut genitalia externa fere sub segmento primo sita sint : abdominis pars dorsalis convexa est, pars ventralis concava. Squamae genitalium externorum fere circulares, magnae, abdominis segmentum ultimum multo excedunt ; valvulae genitales exteriores parvae, triangulares ; valvulae genitales mediae inchoatae ; valvulae genitales internae maximae, squamas 0, 3^{mm} excedentes, apice postice incurvato, caeterum ut in aliis formicis structae."

Anergates atratulus Schenck.

Myrmica atratula Schenck Jahr. Ver. Naturk Nassau **8** 91 (1852)[1]. *Tetramorium atratulum* Mayr Verh. Zool. Bot. Ver Wien **5** 429 (1855)[2]. *Tomognathus atratulus* Mayr Eur. Form. 56 (1861)[3]. *Myrmica atratula* Hagens Berlin Ent. Zeitschr. **11** 106 (1867)[4]. *Anergates atratulus* Forel Denkschr. Schweiz. Ges. Naturw. **26** 341–344 (1874)[5] ; Er. André Spec. Hym. Europe **2** 278 (1881)[6] ; Lubbock Ants, Bees, Wasps 89 (1882)[7] ; Adlerz Bih. K. Sven. Vet. Akad. Handl. **11** 230 (1886)[8] ; Wasmann zusam. Nest. gemischt. Kolon. Ameisen 131 (1891)[9] ; Dalla Torre Cat. Hym. **7** 64 (1893)[10]. *Anergates atratula* Dale Entom. **28** 99 (1895)[11]. *Anergates atratulus* Janet Animaux Myr. 56 (1897)[12] ; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 226 (1908)[13] ; Emery Deutsch. Ent. Zeitschr. **1908** 550[14] ; Wasmann Biol. Centralb. **28** 423–427 (1908)[15] ; Adlerz Arkiv Zool. **5** 1–6 (1908)[16] ; Wheeler Journ. Psy-Neur. **13** 430–432 (1908)[17] : Journ. New York Ent. Soc. **17** 180–183 (1909)[18] : Ants 498–503 (1910)[19] ; Donisthorpe Ent. Rec. **24** 6 (1912)[20] ; Crawley Ent. Rec. **24** 218 (1912)[21] ; Donisthorpe Ent. Rec. **25** 62 (1913)[22] : Rep. Lancs-Chesh. Ent. Soc. 1912 **36** 48–52 (1913)[23] ; Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 68–73 (1913)[24] ; Donisthorpe Ent. Rec. **25** 268 (1913)[25] ; Emery Biol. Centralb. **33** 259 (1913)[26] ; Adlerz Myrornas LIV. 238–239 (1913)[27] ; Schmitz Jaar. Natuur. Genoots Limburg **1915** 132[28] ; Emery Bull. Soc. Ent. Italiana **47** 168 (1916)[29] : Gen. Ins. **171** 206 (1922)[30].

♀ *Black brown ; mandibles, antennae, and legs yellow. The whole body strongly and thickly punctured, distinctly rugose, dull. Wings* slightly fuscous. *Gaster*, in virgin ♀, deeply channelled longitudinally. *Long.* 2·5 mm.

♂ *The whole insect of a dirty yellowish colour, closely and rugosely punctured. Mesonotum* more strongly and less closely punctured. *Fore-legs* furnished with strigils in specimens from Switzerland, not so in specimens from England, France, Holland, and Sweden. *Long.* 2·3 mm.

Ovum : white, roundish.

Larva : yellowish white ; when young, hairy ; more narrow anteriorly than posteriorly ; when older, less hairy and nearly as broad anteriorly as posteriorly, but somewhat attenuate in the middle ; head naked ; the first four somites of the abdomen furnished with long anchor-tipped hairs ; the whole body clothed with both long serrate hairs, and short densely and compactly branching hairs.

Pupa : whitish yellow, becoming the colour of adult when nearly mature.

Original description of *Myrmica atratula* Schenck [Jahr. Ver. Naturk. Nassau **8** 92 (1852)] :—

"Das W. gegenwärtiger Art ist etwa 1½ L. lang, . . . ; bei den befruchteten ungeflügelten Weibchen, welche man im Frühjahr in den Nesten findet, erreicht der Hinterleib eine beträchtliche Dicke und Grösse. Die Farbe ist tief schwarz, fast glanzlos ; der Körper ohne Borstenhaare ; Fühler und Beine mit sehr feinen, kurzen Börstchen. Kopf und Thorax sind sehr fein, nur durch die Lupe merklich, gerunzelt, lederartig. Der Kopf ist kurz, ohngefähr von der Breite des Thorax ; die Fühler sitzen sehr tief, fast am Mundrande. Unter ihrer Wurzel ziehen sich von den Backen her 2 vornen zwischen den Fühlerwurzeln sich mehr oder weniger nähernde bogenförmige erhabene Ränder. Ueber den Fühlern ist der Kopf flach oder eingedrückt, oft lauft eine tiefe Rinne bis zum mittleren Nebenauge. Ein Kopfschild und ein Stirnfeld sind fast nicht vorhanden. Der Scheitel ist höckerig erhöht, der Hinterkopf eingedrückt und ausgebuchtet. Die Netzaugen sind klein, aber stark vorragend, nahe an den Fühlern sitzend ; die Nebenaugen vorspringend. Die Backen sind sehr breit, stark nach hinten erweitert ; von der Seite gesehen erscheint der Kopf fast viereckig. Die Oberkiefer sind klein und schwach, schwärzlich oder bräunlich, nach dem Ende blässer ; die Fühler kurz, heller oder dunkler bräunlich, nach dem Ende blass, braun geringelt ; nur 11 gliedrig ; der Schaft etwa = ⅗ der Geissel, das erste Geisselglied etwas verlängert und verdickt, umgekehrt kegelförmig, die 4 folgenden so lang, als breit, fast cylindrisch, die folgenden allmählig dicker, das letzte so lang, als die 2 vorhergehenden, länglich. Der Metathorax hat statt der Dornspitzen zwei nach oben gerichtete Höckerchen, der Raum dazwischen ist vertieft und glatt. Die Knoten sind sehr breit ; der zweiter ist weit breiter als der erste, oben fast flach, nicht viel schmähler als der Hinterleib, von demselben nur durch eine Fuge getrennt. Der Hinterleib ist kurz und breit, oben ziemlich flach, im Umkreis rundlich, breiter, aber kürzer, als der Thorax. Die Beine sind kurz, bräunlich, Gelenke und Tarsen gelblich. Die Flügel glashell, etwas graulich, Adern und Randmahl nicht gefärbt, die Unterrander aber schwarz ; die Radialzelle offen, die Discoidalzelle fehlt, zuweilen durch den Ansatz einer Querader angedeutet."

Habitat.

Anergates atratulus has been found in Sweden, Holland, France, Switzerland, Germany, and England ; it is also recorded from West Siberia by Emery.

British distribution :—

[**Dorset** : Charmouth (*Dale*)[11]] :
Hants, S. : New Forest (*Crawley* and *Donisthorpe*)[24].

C. W. Dale[11] recorded this species as British, stating that it was taken by his father at Charmouth on July 8th, 1835, and that it is the *Myrmica maculipes* of Curtis's Guide. This name does not, however, occur in Curtis's Guide, and although I have thoroughly overhauled the Dale Collection at Oxford, there is no label nor ant bearing this name, nor does *Anergates* occur in the collection under any other name ; consequently this record must be dismissed as extremely doubtful.*

* Curtis writes [Trans. Linn. Soc. Lond. **21** 216 (1854)] under *Myrmica caespitum* that he had given the name of *maculipes* to the female of that species, and that two females agreeing with Nylander's *M. fuscula* [N.B.

On July 23rd, 1912, *Anergates* was taken in the New Forest by Crawley and myself, in a nest of *Tetramorium caespitum*, the colony consisting of a large number of *Tetramorium* workers, all large and dark in colour ; a number of winged female *Anergates*, three males *in copula* with winged females, one deälated *Anergates* female (the queen-mother), with the gaster enormously distended, and a number of *Anergates* larvae and pupae.

Anergates is only found in the nests of *T. caespitum*. In such *Anergates-Tetramorium* colonies no males, females, nor brood of the host species occur, and Schenck[1] who discovered the species in Nassau, perhaps naturally took the *Tetramorium* workers, with which the *Anergates* occurred, to be those of the latter.

The male of this ant is a most curious object ; it walks with difficulty, looking like a cripple, and both it and the female are fed by the *Tetramorium* workers—they are unable to eat without assistance. The males are licked and carried about by their hosts, but very little attention is paid to the virgin females by the latter. Mating takes place in the nests between brother and sister (adelphogamy), after which the females fly away, presumably to seek other *Tetramorium* nests ; though after fecundation, they soon get rid of their wings in captivity.

The abdominal segments expand enormously some time after the female has lost her wings, becoming so distended with eggs that the chitin which had previously formed segmented rings is now represented only by small black bars separated by broad spaces of white membrane.

The *Tetramorium* workers in these mixed colonies are generally large in size, and dark in colour, showing that they have sprung from an old-established colony. On June 12th, 1913, I found a colony of *T. caespitum* on the Isle of Lundy[25], which contained no brood nor queen (whereas in other nests on the island sex-pupae and a deälated female were found), the workers being the largest specimens I have ever seen, and very dark in colour. This might well have contained a deälated *Anergates* female, but the ground being very hard and stony it was impossible to dig up the nest properly.

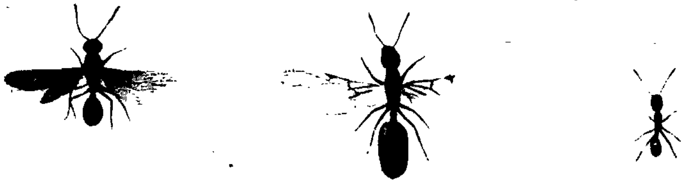
The males and winged females—which are sometimes very numerous, especially the latter—have been found from May to August. Adlerz has described two extraordinary Gynandromorphs

Myrmica fuscula of Nylander = **Tetramorium caespitum L.**—see synonymy of that species, p. 170] were discovered by Mr. Dale under a stone at Charmouth in July—both had lost their wings. There is a deälated female of *Tetramorium caespitum* in the Dale Collection labelled " Charmouth " in J. C. Dale's handwriting—the name " *maculipes* " would describe the female of *T. caespitum*, and there is little doubt that C. W. Dale's record refers to that species.

PLATE VI.

Male, female, and worker of *Formicoxenus nitidulus.*

Male and female of *Anergates atratulus.*



Male, female, and worker of *Monomorium pharaonis.*

Face page 98.

which he reared in an *Anergates-Tetramorium* colony he had taken in Sweden, and established in an observation-nest, as follows[16] :—

1. Imperfect lateral gynandromorph, with the head largely male on the left, female on the right side, the light colour of the male being sharply marked off only anteriorly from the dark colour of the female. Thorax female in front, with wings equally developed on both sides, but with pale coloration on the left and dark coloration on the right, the line of division neither sharp nor straight and the whole post-scutellum blackish brown. Abdomen with irregular arrangement of colour. Petiole black on the right, greyish yellow on the left ; post-petiole mostly blackish brown, but with a large greyish yellow spot on the left side of its anterior surface. Third dorsal tergite blackish brown on the right, yellowish on the left side, the remainder of gaster greyish yellow tinged here and there with pale brown. Third tergite with a median longitudinal groove which runs back on to the succeeding segment as in the virgin female. The left side of the abdomen has seven complete segments and well-developed genitalia, the right side has only six complete segments, and a membranous incomplete seventh. The genitalia are imperfect, the volsella being represented only by a piece corresponding to its dorsal portion and the stipes is wanting. The legs are female, except the left fore-leg, which is male, with a pectinate strigil.

2. Male on left, female on right, resembling the preceding, but with the dark female colour more pronounced on the male side of the head. Wings well developed on both sides, thorax female, though dark on the right and pale on the left, except the epinotum which is entirely greyish yellow. Abdomen almost typically male in colour and form, with the genitalia well developed on both sides, but with a feeble mid-dorsal impression. Legs female, except the left fore one, which is shorter and thicker as in the male, with strigil cleft but not pectinate.

The most interesting problems connected with *Anergates* are, how the female gets accepted by a *Tetramorium* colony, and why there are only workers of the latter present in such colonies. It is evident that the female must enter a *Tetramorium* nest in some way, and be accepted by the workers, when the latter must kill their own queen, or males and winged females if present, since the *Anergates* female can hardly be strong enough to accomplish this herself. *Anergates* colonies are everywhere exceedingly scarce and difficult to find, whereas the host species is generally abundant and common where it occurs, and this evidently indicates that the founding of an *Anergates* colony is by no means a simple matter. Since *Anergates* is absolutely dependent on the *Tetramorium* workers, and no more of these can be produced, a colony can only last for the length of the life of the hosts.

Forel, Avebury, and Wasmann express the view that *Anergates* is descended from a slave-making species, and on this point Lord Avebury[7] writes :—" In *Anergates,* finally, we come to the last scene of this sad history. We may safely conclude that in distant times their ancestors lived, as so many ants do now, partly by hunting, partly on honey ; that by degrees they became bold marauders, and gradually took to keeping slaves ; that for a time

they maintained their strength and agility, though losing by degrees their real independence, their arts, and even many of their instincts ; that gradually even their bodily force dwindled away under the enervating influence to which they had subjected themselves, until they sank to their present degraded condition—weak in body and mind, few in numbers, and apparently nearly extinct, the miserable representatives of far superior ancestors, maintaining a precarious existence as contemptible parasites of their former slaves."

There is nothing in the structure, however, of this permanent social parasite to prove that it is descended from a slave-making species, and it seems more probable, as pointed out by Wheeler[19], that it is derived from a temporary parasite, or a guest ant, permanently attached to the nest of another species. Emery believes that *Anergates* is descended from *Monomorium*, and that it, or its ancestors, were parasitic on species of the latter genus[26]. The following observations and experiments may be recapitulated here :—Adlerz[8] records a few experiments with *Anergates* females and strange *Tetramorium* colonies, in Sweden. He introduced several unfertilized females into a strange colony of *Tetramorium*, when the former moved about almost unnoticed among these ants, and nearly the same results were obtained by introducing unfertilized females into another nest of *Tetramorium* which possessed a queen and brood of its own species. A number of males, females, larvae, and pupae of *Anergates* was introduced into an artificial nest which contained a colony of *Tetramorium*, and all were amicably received.

Wasmann[9] obtained similar results in Holland, males and females of *Anergates* being received and not attacked by *Tetramorium* workers. Janet[12] placed together in an observation-nest a normal colony of *Tetramorium* with a queen, and an *Anergates-Tetramorium* colony, consisting of an obese queen, males, young winged females and *Tetramorium* workers. Very little fighting took place, but some days later the *Anergates* queen was dead, though still attended by the *Tetramorium* workers. Some weeks later all the *Anergates* had disappeared, an unmixed *Tetramorium* colony being the result.

Wasmann[15] found a very strong *Anergates-Tetramorium* colony in Luxemburg in May which contained an obese female, over 100 winged females, several dozen males, over 1000 *Anergates* pupae (mostly female), and some 2000 old *Tetramorium* workers, which were of medium size. The greater part of this colony was placed in an observation-nest, when pairing between the sexes was observed, and after fecundation the females endeavoured to leave the nest—*Tetramorium* worker pupae from a strange nest were given to this colony, but were devoured. He introduced twelve winged but fertilized *Anergates* females—males being in copula

with two of them—into an observation-nest containing 100 *Tetramorium* workers and pupae. One female was attacked and her wings removed, the rest, however, being readily received, but no female was taken as a queen, and all the *Anergates* had disappeared in a few weeks. Wasmann suggests that a female may be adopted into a queenless old *Tetramorium* colony, or perhaps in a branch nest of an old colony.

Wheeler[17] discovered near Vaud, on June 6th at 2 p.m., a medium-sized *Tetramorium* colony from which *Anergates* females were escaping in considerable numbers and flying away in all directions over the sun-lit grass. Forel having joined him, the nest was excavated with great care, when the obese mother queen of *Anergates*, several hundred *Tetramorium* workers, more than a thousand *Anergates* winged females, a few hundred males, and some larvae and pupae were dug up and placed in a bag for experimental purposes. Fertilized females from this colony were placed near the openings of eight nests of *Tetramorium* in Forel's garden at Chigny, when some of them entered nests without attracting much attention. In other instances, females were carried into the nests by the workers, males, on the other hand, being treated with some animosity, carried away and abandoned. One vigorous colony, however, behaved differently; males and females placed near the entrance being seized, pulled about, and carried some distance away. Later in the day some of the females that had entered the nests were brought out and thrown away, and the fact that none of these nests finally accepted an *Anergates* female as their queen was proved by Forel, who examined them next year, and found that they contained no *Anergates*, but male and female *Tetramorium* pupae were present in all of them.

Several experiments[24] with *Anergates* females from the New Forest and *Tetramorium* colonies in observation-nests were carried out by Crawley and myself, these females being attacked and killed by the *Tetramorium* workers, except in one experiment,—thus contrary to the results obtained by Adlerz and Wasmann, in which it will be remembered they were readily received. My observation-nest contained a fertile deälated female *Tetramorium*, workers and larvae, which had been taken at Whitsand Bay in July, 1911. In one experiment on July 25th, 1912, the *Anergates* female, when introduced into this nest, seized a *Tetramorium* worker by one antenna and held on for some time (in all Crawley's experiments the same thing took place), eventually letting go and walking about among the ants—the *Anergates* was sometimes picked up and carried about by a worker, remaining quite quiet and doubled up, but eventually entering the chamber containing the *Tetramorium* queen and the greatest number of workers; there she was cleaned by some of the workers and was evidently accepted by them, and quite at home, not having been attacked in

any way for some hours, when the nest, having been left in the sun, the workers became unduly excited and the *Anergates* female was killed and cut in two.

Crawley's observation-nest contained a large number of winged female *Tetramorium*, males, and pupae, besides workers, obtained in June, 1912, at Seaton. Two of the females had recently got rid of their wings in the nest; whether they had been impregnated by their brothers or not is unknown, but this point is important in view of the fact that the nest contained no old fertile queen. On July 25th, 1912, an *Anergates* female holding a *Tetramorium* worker by the tip of an antenna was introduced into this nest and by next day she was definitely accepted as queen. In a few days' time all the *Tetramorium* males and females were killed and cut up by the workers and their bodies piled in a heap, and from thence onward the *Anergates* female was always treated as their queen, and her gaster commenced to swell, though unfortunately she died in the early part of next year, without having laid any eggs.

It seems fairly certain from these experiments, that when an *Anergates* female has entered a *Tetramorium* nest, and has been accepted by the *Tetramorium* workers—the seizing of the antennae of the latter by the female being probably an important factor in this acceptance (Adlerz in his recent book also records this fact[27])—the latter then kill their own queen, or males and winged females if present, and devote themselves to the rearing of the offspring of the parasite; but it also seems probable that these acceptances are of rare occurrence, and it should be noted that no *Anergates* brood has actually been reared in captivity.

MONOMORIUM Mayr.

[μόνος, single, μόριον, part (i.e. the maxillary palpi).]

Type: **Monomorium minutum** Mayr (Mayr, 1855).

The Genus *Monomorium* comprises a number of species which are distributed over the whole of the warmer parts of the entire world. Several tropical species have become cosmopolitan, being carried by commerce all over the globe, and inhabiting houses, where they have developed into a serious pest—one of these, *Monomorium pharaonis*, being the only species thoroughly established in Britain.

☿ *Head* longer than broad, oval, or rectangular; *clypeus* large, convex, subtriangular, projecting a little over the base of the mandibles, with two obtuse carinae meeting between the base of the antennae; *mandibles* narrow, terminal border armed with three or four sharp teeth; *maxillary palpi* one- or two-jointed; *labial palpi* two-jointed; *frontal carinae* short and parallel; *antennae* eleven-, or twelve-jointed; first joint of *funiculus* long, the following joints, between the first and the club, short and transverse, *club* three-jointed as long as the rest of the funiculus, its last joint as long as the two preceding

together ; eyes oval, generally small. *Thorax* long and narrow, rounded and a little broader anteriorly ; suture between the pronotum and mesonotum obsolete, deeply marked between the mesonotum and epinotum ; *epinotum* unarmed. *Petiole* cylindrical anteriorly, furnished with a high node posteriorly ; *post-petiole* transverse, its node less high than the petiole ; *gaster* oval, emarginate in front, with distinct anterior angles.

♀ *Head* as in the ☿. *Thorax* narrow, higher than broad ; *mesonotum* long, projecting over the pronotum ; *epinotum* unarmed. *Wings :* fore-wings with one cubital cell and no discoidal cell. *Size* much larger than in the ☿.

♂ *Head* before ocelli flat and broad ; *clypeus* broad and convex ; *mandibles* strong, dentate ; *antennae* thirteen-jointed, *scape* short, not as long as the first three joints of the antennae together, *funiculus* with apical joints a little broader, not forming a distinct club. *Thorax* high ; *mesonotum* without Mayrian furrows ; *epinotum* unarmed. *Wings* as in the ♀.

Original description [Mayr Verh. Zool. Bot. Ver. Wien **5** 452 (1855)] :—

" μόνος eines, μόροιν Glied.

Arbeiter : Der Kopf ist länger als breit, und breiter als der Thorax. Die Oberkiefer sind mässig breit, am Innenrande mit grossen, spitzen Zähnen bewaffnet. Die Unterkiefertaster sind eingliedrig, an der Spitze mit einer Borste. Die Lippentaster sind zweigliedrig, das erste Glied ist sehr dünn, das zweite sehr dick, beide ziemlich gleichlang. Die Oberlippe ist vorne zweilappig. Der Clypeus reicht zwischen den Fühlern bis hinter dieselben, ist in der Mitte stark gewölbt und von dem höchsten Puncte der Wölbung, welche zwischen den Fühlern liegt, zieht sich eine breite Rinne in der Mittellinie zum Vorderrande des Clypeus, welcher an dieser Stelle schwach ausgerandet ist. Die Fühler sind zwölfgliedrig, die Geissel ist am Ende stark keulenförmig verdickt, die Keule ist aus den drei letzten Gliedern gebildet. Die Punctaugen fehlen. Die Netzaugen sind klein, etwas näher dem Mundrande als dem Hinterrande des Kopfes. Der Thorax hat zwischen dem Meso- und Metanotum eine breite Furche und ist kaum eingeschnürt. Das Metanotum hat keine Dornen und keine Höcker. Das erste Glied des Stielchens ist vorne kurz stiel—hinten knotenförmig ; das zweite Glied ist knotenförmig, etwa so breit als der Knoten des ersten Gliedes, aber nicht so hoch ; beide Glieder sind unten ungezähnt. Das erste Hinterleibssegment bedeckt mehr als zwei Drittheile des kleinen, rundlichen Hinterleibes."

Monomorium pharaonis L.

Formica pharaonis Linnaeus Syst. Nat. **Ed. 10 1** 580 sp. 7 (1758)[1]. *Formica antiguensis* Fabricius Entom. Syst. 2 357 (1793)[2]. " Minute Ants " [=*Monomorium pharaonis*] " J.D." Mag. Nat. Hist. **7** 369 (1834)[3]. *Formica unifasciata* Spence Proc. Ent. Soc. Lond. **1834** XXV (1835)[4]. *Myrmica unifasciata ?* Bostock Trans. Ent. Soc. Lond. 2 65–67 (1837)[5] : Proc. 2 XXVIII–XXIX (1837)[6]. *Myrmica domestica* Shuckard Mag. Nat. Hist. (n.s.) 2 626 (1838)[7]. *Myrmica domestica* (=*M. unifasciata*) Shuckard and Bostock Proc. Ent. Soc. Lond. 2 LI–LII (1839)[8]. *Myrmica domestica* Westwood Gardeners' Chron. **10** 22p. 340 (1850)[9]. *Atta minuta* Jerdon Madras Journ. Lit.-Sc. **17** 105 (1851)10. *Myrmica domestica* Daniel Proc. Linn. Soc. 2 172–177 (1852)[11] ; Wakefield Zool. **11** 3810 (1853)[12] ; Curtis Trans. Linn. Soc. **21** 217 (1854)[13]. *Myrmica* (*Aecophthora*) *domestica* Nylander Ann. Sc. Nat. Zool. (4) 5 98 (1856)[14]. *Myrmica* (*Diplorhoptrum*) *molesta* F. Smith Trans. Ent. Soc. (n.s.) 4 284 (1858)[15]. *Myrmica* (*Diplorhoptrum*) *molesta* F. Smith Cat. Brit. Foss. Hym. 34 (1858)[16]. *Diplorhoptrum fugax* Lucas Ann. Soc. Ent. France (3) **VI** LXXXI (1858)[17]. *Monomorium pharaonis* Mayr Verh. Zool. Bot. Wien **12** 752 (1862)[18].

Myrmica molesta F. Smith Ent. Ann. **1863** 59–63[19]. *Diplorhoptrum molesta* "H. G. K." [? Knaggs] Science Gossip **1865** 170[20]; F. Smith Ent. Mo. Mag. **2** 29 (1865)[21]; Shuckard Science Gossip **1866** 272[22]. *Myrmica domestica* I. Sharp Entom. **4** 232 (1869)[23]; Gillam Entom. **5** 83 (1870)[24]. *Diplorhoptrum domesticum* Gaskell Ent. Mo. Mag. **13** 254 (1877)[25]. *Myrmica domestica* B. Cooke Nat. **5** 73 (1879)[26]. *Diplorhoptrum domesticum* Bridgman Trans. Norf. Norwich Nat. Soc. **2** 621 (1879)[27]. *Diplorhoptrum molesta* Parfit Trans. Devon Assn. Sc.-Art **12** 517 (1880)[28]. *Monomorium pharaonis* Saunders Trans. Ent. Soc. Lond. **1880** 222[29]; Bignell Young Nat. **3** 303 (1882)[30]. †*Ciphlorophum domesticum* Chappell Young Nat. **8** 63 (1887)[31]. *Monomorium pharaonis* Bellevoye Soc. Etud. Sci.-Nat. Reims **1** 21–37 (1891)[32]; Dalla Torre Cat. Hym. **7** 68 (1893)[33]; E. A. Butler Household Insects 57–61 (1893)[34]. *Diplorhoptrum domesticum* Farren-White Ants' Ways 246 (1895)[35]. *Monomorium pharaonis* Saunders Hym.-Acul. **41** (1896)[36]; Service Scott-Elliott's Flora Dumfries XV (1896)[37]; Morley Entom. **31** 13 (1898)[38]; Evans Ann. Scot. Nat. Hist. **8** 117 (1899)[39]; Vic. Hist. Cumberland **1** 103 (1901)[40]; Vic. Hist. Essex **1** 99 (1903)[41]; Godfrey Ann. Scot. Nat. Hist. **12** 247 (1903)[42]; Vic. Hist. Warwick **1** 74 (1904)[43]; Vic. Hist. Durham **1** 95 (1905)[44]; Vic. Hist. Cornwall **1** 182 (1906)[45]; Vic. Hist. Berks **1** 72 (1906)[46]; Bingham Bull. R. Bot. Gard. Kew (a.s.) **5** 28 (1906)[47]; Vic. Hist. Yorks **1** 217 (1907)[48]; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 230 (1908)[49]; Wheeler Ants 154[50] 573[51] (1910); Forel Int. Ent. Cong. Brux. 1910 **2** 83 (1911)[52]; G. Wheeler Proc. Ent. Soc. Lond. 1911 LVI (1912)[53]; Schmitz Jaar. Natuur. Genoots Limburg **1915** 125[54]. *Monomorium* (*Monomorium*) *pharaonis* Emery Bull. Soc. Ent. Italiana **47** 161 (1916)[55]. *Monomorium pharaonis* Donisthorpe Ent. Rec. **28** 2 (1916)[56]: **31** 1 (1919)[57]. *Monomorium* (*Monomorium*) *pharaonis* Emery Gen. Ins. **174** 172 (1922)[58]. *Monomorium pharaonis* Donisthorpe Ent. Rec. **36** 49 (1924)[59].

Dalla Torre[33] cites *Myrmica molesta* Say [Boston Journ. N. H. **1** 293 (1836)] as a synonym of *Monomorium pharaonis* L., but Emery and Wheeler both tell me that the former is a *Solenopsis* and not a *Monomorium*, and I have seen specimens taken in America by Crawley which had been named *Solenopsis molesta* Say, by Forel; these certainly are not *M. pharaonis* L.

☿ *Reddish yellow, eyes black, gaster blackish posteriorly, with only a few scattered hairs on the pedicel and gaster, pubescence almost wanting. Head, thorax* and *pedicel* closely punctured and dull; *gaster* shining. *Long.* 2–2·4 mm.

Fig. 60. *Monomorium pharaonis* ☿.

♀ *A little darker in colour, with eyes considerably larger than in the* ☿. *Head* slightly blackish. *Thorax: mesonotum* with a narrow blackish longitudinal patch not quite reaching the middle. *Wings* slightly fuscous. *Gaster* more distinctly blackish posteriorly than in the ☿. *Long.* 4–4·8 mm.

♂ *Black, mandibles, antennae and legs yellow, the femora, scape and apex of the funiculus fuscous.*

Eyes very large. *Head, thorax,* and *pedicel* closely punctured and dull; *gaster* shining. *Wings* transparent. *Long.* 3 mm.

Larva: Short and compact, broadest posteriorly, white. *Head* transparent, shining, the rest of the body rugose longitudinally, clothed with short,

slightly curved, scattered hairs. The whole larva looks superficially like a bit of broken camphor.

Pupa: White, striate transversely; becoming yellow when mature.

Original description of *Formica pharaonis* Linnaeus [Syst. Nat. **Ed. 10. 1** 580, sp. 7 (1758)] :—

"*F. rufa*, abdomine magis fusco. M. L. U.
Habitat in Aegypto; *minima.*"

Habitat.

Monomorium pharaonis has been spread by commerce nearly all over the world, inhabiting houses, bakers' shops, etc., and also living on board ships.

British distribution :—

Cornwall, W. : Falmouth[45].

Devon, S. : Exeter (*Parfitt*)[28]; Plymouth (*Parfitt*)[28].

Wilts, S. : Salisbury (*O. P. Cambridge*)[59].

Dorset : Dorchester (*Haines*).

Isle of Wight : Ventnor (*F. Smith Coll.*).

Hants, S. : Winchester (*Wakefield*)[12]; Bournemouth (*Barnes*).

Sussex, E. : Brighton (*Spence*)[4]; Hastings (*Shuckard*)[22]; St. Leonards (*Farren-White*)[35].

Kent, E. : Folkestone (*Farren-White*)[35]; Hythe (*Donisthorpe*)[49].

Surrey : Southwark (*Bostock*)[6]; Crystal Palace (*Rothney Coll.*); Ewell (*Harrison, Saunders Coll.*).

Essex, N. : Colchester and Dovercourt[41].

Middlesex : London (*Bostock*[6], *etc.*).

Berks : Reading[46]; Windsor (*Miss F. Kirk*).

Suffolk, E. : Ipswich (*Morley*)[38]; Wherstead (*Morley*)[38].

Norfolk, E. : Norwich (*Bridgman*)[27]; **Norfolk, W.** : King's Lynn (*Atmore*).

Gloucester, W. : Stonehouse and Stroud (*Farren-White*)[35]; Bristol (*Morice Coll.; Wormsley*); Clifton (*Miss Roper*).

Warwick : Birmingham[43].

Glamorgan : Cardiff (*Hallett*).

Notts : Nottingham (*Thornley*)[59].

Cheshire : Stockport (*Gaskell*)[28].

Lancashire, S. : Liverpool (*Bostock*)[8]; Manchester (*Gillam*)[24]; **Lancashire, Mid.** : Preston (*Donisthorpe*)[59].

York, S.E. : Hull[48]; **York, N.E.** : Middlesbrough (*I. Sharp*)[23]; **York, N.W.** : Leeds[48].

Durham : Dipton district, etc.[44]; Ryhope near Sunderland.

Cumberland : Carlisle[40].

Dumfries : Dumfries (*R. Service*)[37].

Lanark : Glasgow (*J. F. X. King Coll.*).

Edinburgh : Edinburgh (*Evans*)[39].

Perth, Mid. : Crieff (*Godfrey*)[42]; Rannoch (*Foxcroft, Brit. Mus. Coll.*).

Kincardine : Auchniblae near Fordown (*Waterston*).
Aberdeen, S. : Aberdeen (*Morison*).
Donegal : Ballyshannon (*Halbert*).
Dublin : Dublin (*Stelfox*)[59].
Wicklow : Aghadoe Church (*Haliday*).

Although *Monomorium pharaonis* is not a truly indigenous insect to Britain, still it has become firmly established, and, as has been seen, is widely distributed in our islands, probably inhabiting most of our large towns and seaports. Forel[52], in a paper on the Geographical Distribution of Ants, enumerated eleven cosmopolitan species which have been transported everywhere by ships, this ant being one of them. It has evidently been breeding here for nearly one hundred years—probably longer—and appears to have been first recorded in London in 1828[22]. It was notified[3] as being very abundant in 1833 in the kitchen of a house in Kensington Gravel Pits, and Spence[4] pointed out in 1834, that it was so numerous in several houses in London and Brighton that the inhabitants had to quit their dwellings. At a meeting of the Entomological Society of London on November 7th, 1836, Bostock[6] stated that it was inhabiting the kitchen of his house in Upper Bedford Place, and that it extended from Gray's Inn Lane in the east as far as Regent Street in the west, from the commencement of Somers Town to the Strand, and that it occurred in Hampstead and Southwark; Waterhouse remarked that it was to be found in Billingsgate. It has also been recorded from Portman Square in 1852[11], Regent's Park district in 1853[12], and Russell Square in 1865[20], and G. C. Leman took it in the Connaught Rooms in 1923. Colonel Bingham[47] gives it in his list of the ants at Kew Gardens, and the writer took it in the Reptile House in the Zoological Gardens[49] in 1894—where it is still in abundance—and in a baker's shop in the Earl's Court Road. According to Wakefield[12] it occurred in thousands in an hotel at Winchester in 1846.

It evidently originated in some tropical country, Smith[15] suggested that it came from Brazil, where it is common, and Linnaeus[1] gives its habitat as Egypt. Wheeler[50] when referring to its presence in America points out that it does not nest out of doors except in southern latitudes. In our own islands it is confined to houses, etc., though Morley[38] actually swept a specimen from a hedge-bottom on July 2nd, 1897, at Wherstead, at least a mile from any shop or habitation.

Its colonies are often of vast proportions. Robert Service[37] mentions that he was called in to see this ant at home in a house in Dumfries which it had overrun from cellar to attic. Its myriads were past comprehension, and in some places it distinctly coloured the white wall with its hosts; and Bellevoye[32], who studied its habits in his house at Reims, computes that he captured in twenty-

four months, 1,360,000 workers, 1809 deälated females, 34 winged females, and 566 males !

Smith gives August as the time for this ant to swarm[21], and a small colony, sent to me by Blenkarn from Beckenham in August, 1912, which was nesting in a sword case, contained one male, several winged and deälated females, workers and brood ; on the other hand, a male and winged female in Saunders' Collection were captured by Harrison on June 26th, 1893, at Ewell.

Bellevoye[32] shows, however, that the males appear rarely at the end of June and continue till the end of October, in which month they are the most abundant, disappearing in November; the winged females occur chiefly in September and October, and the deälated females all the year round, being seen more abundantly in the summer.

He is of opinion that they never use their wings for the marriage-flight, but that copulation takes place in the nests or their galleries, the fertilized females then losing their wings and joining the community, and the males gradually dying off. The latter are quicker in their movements than the females, and use their wings to assist themselves in rapidly gliding along the surface.

This ant is very voracious, eating greedily all kinds of sweets, sugar, cakes, etc. ; it is very fond of meat and freshly killed insects and will also devour butter and other fats. Daniel[11] utilized their penchant for meat in the preparation of skeletons—removing the skin and most of the flesh from the small animals he wished to skeletonize, he placed them where the ants could get at them, and thus obtained over one hundred beautiful skeletons of small quadrupeds, birds, reptiles, and fishes, which he gave to the British Museum.

On May 10th, 1915, I visited the Reptile House at the Zoological Gardens with the intention of capturing larvae of this ant for photographic purposes. Many workers were soon observed running along their tracks, carrying what appeared to be larvae, and were promptly bottled. On reaching home, however, I found that very few of the objects carried by the ants were larvae. They mostly consisted of very minute portions of lizard skins, very small stones, and other unrecognizable substances. The bits of lizard skins probably serve as food ; but it is difficult to understand to what use the ants would put the small stones and other apparently inedible-substances[56].

In February, 1926, Morison informed me that it had been very well established for at least three years at the Corporation Bathing Station at Aberdeen.

The Rev. G. Wheeler[53] stated that some freshly set butterflies in his possession were destroyed by this ant ; and he found that they only devoured those specimens which had been killed in the cyanide bottle, whilst others, in the same setting box, into which

oxalic acid had been injected, were left untouched. This ant has been said to be very destructive to the common "Bed-bug," but Walker found when both species occurred on board a ship in which he was travelling that they lived together in perfect amity[53].

Tracks are formed from the entrances to their dwellings, which all the ants follow when they go abroad, passing and repassing each other and never deviating from the beaten route. If one of these tracks be watched, deälated females will be observed at intervals amidst the hurrying crowds of workers, and in the course of their progress sometimes laying eggs, which are immediately collected by the workers, and occasionally one of the latter will be seen to carry a larva about with it on the march. Daniel[11], however, stated that the pupae were carried about by both the males (!) and workers.

They must possess a very remarkable sense of smell, or some other faculty which enables them to discover the whereabouts of any comestible suitable to them :—In August, 1893, when staying at the Seabrook Hotel, at Hythe[49], I captured workers in the coffee-room which were brought up from the kitchens on plates, etc., though I had never seen any sign of them upstairs, but on looking in a box which contained some beetles, freshly killed and set, which I had placed in a drawer in a chest-of-drawers in my bedroom, I was surprised to find it full of these little creatures.

Bellevoye[32] also gives several instances of this kind—on one occasion he had placed two recently captured spiders in a box on a window-sill on the second étage in his house and on looking at them next day he found the box full of these ants (the abdomens of both spiders had been devoured), and he added, as a rule, they were never seen upstairs. He repeated this experiment again with the same result, and at another time, having pinned some recently killed dragon-flies in a glass case which was kept upstairs and which had always contained some old dry specimens, the ants soon appeared and cleaned out the bodies of the fresh dragon-flies, leaving the old dry ones untouched.

When once *Monomorium pharaonis* has become established anywhere it is almost impossible to get rid of it, since it nests in the foundations, in walls and under the floors in houses, and at the back of the ovens in bakeries, etc. Dr. Bostock[6] had the whole of his kitchen floor taken up, the grate and part of the walls and woodwork removed, and new tiles set in cement fixed on the walls and floor, and even then this pest was not eradicated. Wheeler[51] suggests pouring, or injecting, boiling water, benzine, gasolene, or preferably carbon bisulphide into the crevices which the insects inhabit. Vast numbers can be destroyed by placing pieces of meat, sponges soaked in sugar and water, and bones near the tracks, and when they are covered with ants, plunging them into boiling water, but this only gives temporary relief, since as

long as there are a number of fertile females in the nests, the ants thus killed will soon be replaced.

I have several times endeavoured to keep this species in captivity, introducing queens and numbers of workers into plaster nests, but the ants do not appear to be able to live in close confinement, the workers soon dying off in large numbers, and the whole colony eventually perishing.

SOLENOPSIS Westwood.

[σωλήν, channel; ὄψις, face (i.e. the channel on the head).]

Type: **Atta geminata F.** (=*mandibularis* West.; West., 1841).

Solenopsis is a large genus, about half the species of which are proper to America, the remainder being distributed over Asia, Africa, and Australia. Some seven species belong to the Palaearctic Region, of which only two occur in Europe. Dimorphism is very prevalent in the workers of the exotic species, especially the American, soldiers with very large heads being present; the variation in the workers of the Palaearctic species, however, is not nearly so marked. Many species are very hypogaeic in habits, living underground as robbers in the nests of other ants.

☿ *Head* somewhat square, anteriorly with a distinct channel in the middle; *clypeus* armed with two teeth on the anterior margin, these teeth converging back between the base of the antennae as carinae; *mandibles* narrow, terminal border furnished with four teeth; *maxillary palpi* and *labial palpi* two-jointed; *antennae* ten-jointed, with a distinct two-jointed club, the last joint of which is very long; *eyes* small and flat. *Thorax* with suture between pronotum and mesonotum obsolete; suture between mesonotum and epinotum distinct and deep; *epinotum* unarmed. *Petiole* cylindrical anteriorly, nodiform posteriorly; *post-petiole* transverse, nodiform, not so high as petiole; *gaster* oval, with first segment longer than half the gaster; *sting* very large.

♀ Much larger than the ☿. *Antennae* as in the ☿, but eleven-jointed; *eyes* projecting, much larger than in the ☿; *ocelli* present. *Wings*: *fore-wings* with a closed cubital cell, and one discoidal cell, radial cell open.

♂ Smaller than the ♀. *Head* short; *clypeus* convex; *mandibles* narrow, armed with three teeth; *maxillary* and *labial palpi* two-jointed; *antennae* twelve-jointed, scape short, the first joint of the *funiculus* swollen and globular. *Thorax*: *mesonotum* without Mayrian furrows; *epinotum* unarmed. *Wings* as in the ♀.

Original description [Westwood Ann. Mag. N. H. **6** 86 (1841)]:—

"(σωλήν, *canalis*, et ὄψις, *fascies*, ob *faciem canaliculatam*.)
Characteres e pseudo-foemina desumpti.

Caput maximum subquadratum horizontale posticè emarginatum, suprà linea media longitudinali in duas partes divisum anticè in medio bituberculatum. Oculi parvi laterales ante medium marginis locati.

Antennae breves graciles prope os in foveolis duabus insertae; ten-articulatae, articulis duobus apicalibus majoribus.

Labrum parvum inter mandibulas et supra os deflexum bilobum.

Mandibulae magnae valde curvatae crassae apice obliquo, edentulae.

Maxillae et mentum minima fere membranacea, labium subductum.
Palpi maxillares et labiales biarticulati; gracillimi brevissimi, apice seta instructi.
Thorax valde angustus, prothorace mediocri; mesothorace majori.
Abdomen magnum fere circulare subdepressum segmentis basalibus duobus nodos duos formantibus, segmento proximo maximo.
Pedes graciles tibiis 4 posticis ecalcaratis, unguibus tarsorum simplicibus."

Solenopsis fugax Latr.

Formica fugax Latreille Ess. Hist. Fourmis France 46 (1798)[1]. *Myrmica flavidula* Nylander Acta. Soc. Sc. Fenn. 3 43 (1849)[2]. *Myrmica fugax* Schenck Jahr. ver. Naturk. Nassau **8** 107–110 (1852)[3]. *Myrmica flavidula* F. Smith Proc. Ent. Soc. London (n.s.) **3** 24 (1854)[4]. *Diplorhoptrum fugax* Mayr Verh. Zool. Bot. Ver. Wien **5** 450–452 (1855)[5]. *Myrmica fugax* F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 127 (1855)[6]. *Myrmica* (†*Diphlorhoptrum*) *fugax* F. Smith Trans. Ent. Soc. Lond. (n.s.) **4** 283 (1858)[7]: Cat. Brit. Foss. Hym. 33 (1858)[8]. *Diplorhoptrum fugax* F. Smith Ent. Mo. Mag. **2** 29 (1865)[9]. *Solenopsis fugax* Forel Mitt. Schweiz. Ent. Ges. **3** 105–128 (1869)[10]: Denkschr. Schweiz. Ges. Naturw. **26** 385[11] 411–412[12] (1874); Saunders Trans. Ent. Soc. Lond **1880** 221[13]; Er. André Hym. Europe **2** 388–389 (1881)[14]; Lubbock Ants, Bees, Wasps 78 (1882)[15]; Fowler Ent. Mo. Mag. **19** 139 (1882)[16]: **21** 37–38 (1884)[17]; Wasmann zusam. Nest. gemischt. Kolon. Ameisen 18–26 (1891)[18]; Dalla Torre Cat. Hym. **7** 75 (1893)[19]; Richardson Ent. Mo. Mag. **30** 213 (1894)[20]; Wasmann Krit. Ver. Myr. Ter. Art. 162 (1894)[21]; Farren-White Ants' Ways 246 (1895)[22]; Saunders Hym. Acul. 41 (1896)[23]; Janet Animaux Myr. 58–60 (1897)[24]; D. Sharp Camb. N. H. Insects **2** 137 (1899)[25]; Donisthorpe Ent. Rec. **14** 15 (1902)[26]: **20** 282 (1908)[27]: Trans. Leicester Lit.-Phil. Soc. **12** 228 (1908)[28]: Ent. Rec. **21** 258 (1909)[29]; Emery Deutsch. Ent. Zeitschr. **1909** 30[30]; Donisthorpe Trans. Ent. Soc. Lond. **1910** 146[31]; Wheeler Ants 427 (1910)[32]; Santschi Bull. Soc. Sc. Bucarest **19** 649 (1910)[33]; Donisthorpe Ent. Rec. **26** 38 (1914)[34]; Schmitz Jaar. Natuur. Genoots Limburg **1915** 123[35]; Emery Bull. Soc. Ent. Italiana **47** 165 (1916)[36]: Gen. Ins. **174** 201 (1922)[37]; Donisthorpe Ent. Rec. **35** 2 (1923)[38].

Fig. 61. Antenna of *Solenopsis fugax* ☿.

☿ *Reddish yellow (the larger examples being darker, almost brown), the first segment of the gaster being usually darker, very finely punctured, smooth, and shining, hairy. Long.* 1·5–3 mm.

Fig. 62. Antenna of *Solenopsis fugax* ♂.

♀ *Black brown with the mandibles, antennae, legs, the posterior borders of each segment and the underside of the gaster yellow, the whole body being shining and very hairy. Head* and *thorax* more coarsely punctured than in the ☿. *Wings* very slightly fuscous, with the veins and pterostigma yellowish brown. *Long.* 6–6·5 mm.

♂ *Black, shining, with the mandibles, apex of antennae, tarsi, and extremity of gaster yellowish; hairs shorter, and more upstanding than in the ♀. Head* (except the *clypeus*) the *pronotum,* part of the *mesonotum, epinotum* and *pedicel* finely rugose; *gaster* smooth. *Wings* as in the ♀, but more transparent. *Long.* 4–4·8 mm.

Ovum: Very small, round, white.
Larva: Pyriform, though somewhat narrowed at the extreme base, covered with short curved hairs. The smaller larva (☿ ?) are yellow, smooth and shining, the larger ones (♂ ♀ ?) are white, duller and more rugose.
Pupa: Slightly rugose and dull, white, looking as if they had been cut out of wax. Sex pupae adult colour before emergence.

Original description of *Formica fugax* Latreille [Ess. Hist. Fourmis France 46 (1798)] :—

" F. fugace, *fugax.*
O.t.p. Testacée pâle. Abdomen noir à sa base. *Mâle.* Noir, un peu pubescent, luisant. Antennes, genoux des cuisses, jambes et tarses en grande partie, obcurs. Ailes transparentes. *Femelle.* Tête, corcelet, nœuds, d'un noir reluisant. Antennes, pattes, d'un brun clair. Anneaux de l'abdomen d'un brun foncé, roussâtres à leur base. Ailes transparentes."

Habitat.

Solenopsis fugax is found in South and Central Europe, West and Central Asia, and in Japan; a variety occurring near the Sea of Aral[30].

The British distribution is as follows :—

Cornwall, W. : The Lizard (*Keys*).
Dorset : Portland (*Richardson*)[20]; Swanage (*Nevinson*).
Isle of Wight : Sandown (*Fowler*)[16]; Blackgang (*Donisthorpe*)[27].
Kent, E. : Deal (*F. Smith*)[7].
Essex, S. : Shoebury near Southend (*F. Smith*)[4].

This ant was first discovered in Britain by Frederick Smith, who exhibited it at a meeting of the Entomological Society of London on September 4th, 1854, under the name of *Myrmica flavidula,* stating that it was a new species, and that he had taken it at Shoebury near Southend[4]. Subsequently he records that he discovered a colony underground on the shore below Southend in the autumn of 1854, and that he could always find workers by digging, but they never appeared above the surface. Male and female pupae were found in small chambers at the depth of about six inches, though he was never able to rear them[6]; but he captured a female on the Deal sand-hills in the autumn of 1857[7].

It does not appear to have occurred again in England till Easter in 1882, when Fowler found a colony under a stone at Sandown in the Isle of Wight[16], and again on April 12th, 1884, while collecting at the foot of the Culver Cliffs near Sandown he came across a nest of this ant, and writes as follows—" On pulling at a large stone to

remove it from the side of the slope in which it was imbedded, the top, which fitted very closely, came off in my hand, and between it and the lower part the *Solenopsis* had formed its nest: owing to the position of the stone on a slope, the crack was in direct communication with the side of the hill in which it was imbedded, and here a large colony of *Formica fusca* had settled behind the stone; not one of the latter, apparently, could have got into the crack, but the *Solenopsis* had, of course, easy access to the *F. fusca*."[17]

In June, 1894, Richardson took a dozen workers at Portland under a stone, and he mentions that this stone was situated about half-way between nests of *Acanthomyops niger* and *A. flavus*[20].

I found a colony (on May 4th, 1904), situated in the side of the cliff at Sandown, which was not connected with any other ants' nest[28], workers only being observed, and in August, 1908, I discovered it at Blackgang Chine at the roots of *Arenaria maritima* in company with both *A. niger* and *A. flavus*, though in some cases the *Solenopsis* appeared to be alone[27], and again at Sandown in 1909 the workers were abundant with *A. niger* in the sides of the cliffs[29].

On August 10th, 1913, Crawley and I took five or six workers in a nest of *Formica fusca* v. *glebaria* at "Limpet Run" near Sandown[35], the only specimens that could be found, but on August 26th, 1913, I discovered a very large colony at Blackgang[34]. This nest was situated at the foot of the cliffs in a large block of greensand over two feet long by a foot broad, which, when I endeavoured to lift it up, split in two, the whole of the top half coming away bodily in my hands. The surface thus revealed was quite black with the great numbers of males present, and underneath them countless thousands of the small yellow workers occurred. Small chambers had been excavated in the sandstone which contained large numbers of larvae of all sizes, eggs, worker and male pupae, but only one female pupa was found, which was subsequently reared. Only two winged females were observed, and no deälated female could be traced, but, as Forel[12] has pointed out, the latter are very difficult to find. There was no other ants' nest in the immediate vicinity, and the most careful investigation failed to produce any myrmecophiles or *Aphidae* among the *Solenopsis*.

This little robber ant is subterranean in its habits—the workers, which are nearly blind, very seldom coming up above ground—and it generally lives in the nests of other species, where it preys on their brood, building small chambers in or beneath their nests. Very fine galleries allow them to gain access to the runs and dwellings of their hosts, these galleries, however, being far too narrow to permit the entrance of the latter. Forel[10] bas compared them to mice which live in our dwellings, and Lord Avebury[15] has pictured the situation as follows—"*Solenopsis fugax*, which makes

its chambers and galleries in the walls of the nests of larger species, is the bitter enemy of its hosts. The latter cannot get at them, because they are too large to enter the galleries. The little *Solenopsis*, therefore, are quite safe, and, as it appears, make incursions into the nurseries of the larger ant, and carry off the larvae as food. It is as if we had small dwarfs, about eighteen inches to two feet long, harbouring in the walls of our houses, and every now and then carrying off some of our children into their horrid dens."

The marriage-flight takes place in September and October, and although there are a number of males and winged females in the Dale Collection at Oxford, taken by him on August 26th and 28th, 1895, at Portland, these were probably found in the nests, as was the case with my Blackgang specimens.

Schenck[3] gives September 22nd and October, Mayr[5] states that large swarms of the males and females may be seen in the air on still warm evenings after rain in the autumn, and Forel[12] says the males and winged females are to be found in the nests from the beginning of August to September, and records marriage-flights towards the end of the afternoon on September 5th, 16th, and 24th. He[10] has observed the workers attending the winged forms, when they came out of the nest, as far as the herbage, up which the latter climbed preparatory to flying away, and on the same day he has seen couples on the ground, fallen together after the marriage-flight; and he found an isolated fertile female at Vaux on May 9th, 1871[12]

Santschi describes a curious gynandromorph, taken by Montandon at Mangalia in Roumania, in which the head and thorax is female and the pedicel and gaster male[33].

Their colonies are generally very populous; one described by Wasmann[18], which he found in a nest of *Formica pratensis* at Roermond, consisted of 100,000 workers and 20 queens.

Their food consists of the larvae and pupae of other ants, the juices of insects, etc., and they appear to keep and milk root *Aphidae*, indeed André[14] considers this to be their principal means of subsistence, though Janet[24] rather thinks that it consists of the brood of other ants. Both Forel[11] and Wasmann[18] found that they milked a rose-coloured root *Aphis*, and the former[10] also mentions a small yellow species; whilst once having thrown a large cupful of the cocoons of *Formica pratensis* among the herbage he observed a number of the workers of *Solenopsis* come out of the ground and, piercing the cocoons, cut up the pupae[11]. Janet[24] gave every day to the *Solenopsis*—in an artificial double nest he had under observation of *Solenopsis fugax* and *Formica rufibarbis*—ten *Acanthomyops* female cocoons, which he placed near the orifice of the nest. The *Solenopsis* did not wait long before emerging; they climbed to the number of ten to thirty on to each cocoon, and riddled them with openings, which, uniting together, allowed them to get at the

contents. If it contained a pupa the legs and antennae provided an easy handle to the mandibles of the *Solenopsis*, in which case the victim was promptly gashed, sucked, and cut up into quite small particles, which were hastily carried into the interior of the nest. The operation is much more difficult when the contents consist of a larva, as he then saw the *Solenopsis* convey it into the nest and work at it for twenty-four hours, at the end of which time it was covered with small black contiguous spots, corresponding to the little wounds made by their mandibles, and it commenced to become flabby. A number of individuals were occupied in licking the liquid which flowed from these wounds, but the larva did not decrease in size until after thirty-six hours, when it had been entirely devoured.

Wasmann[18] observed a number of *Myrmica lobicornis* female pupae which had been destroyed by *Solenopsis*, and in the summer of 1887 he found in a hillock of the "black-backed wood ant" (*F. pratensis*) several cocoons of a "Gold Beetle" (*Cetonia floricola*) in which a multitude of this little yellow ant were busy eating the dead and half-rotten *Cetonia* pupae.

Isolated nests appear to be far from common; Forel[10] in eight years, though continually finding this ant in the nests of other species —indeed he says it was almost impossible to find a nest of *Formica fusca* which did not contain it—only found three or four such colonies, and suggests that then the host species had deserted the nest, and that it would be very difficult for the *Solenopsis* to follow it, carrying with them their large female pupae. Wasmann[18] seldom found them alone in Holland, and then they were nearly always near to the nest of another ant. Janet[24] who studied the habits of *Solenopsis* at Beauvais, where it was abundant on a piece of waste ground with hardly any stones, often found isolated colonies, but, as he points out, they were never so far from the nests of other ants that they could not easily visit them, or be connected with them

This is a very courageous little species and will fight fiercely with much larger ants, as has also been recorded by Schenck[3], Mayr[5], Forel[10], Wasmann[18], and Janet[24]. When a double nest has been disturbed the *Solenopsis* workers fasten in numbers on to the legs and antennae of the host species, wounding them with their powerful stings. The larger ants, such as species of *Formica*, do not appear to be able to see them properly, biting at the ground and discharging acid without hurting them; the smaller ones, such as species of *Acanthomyops*, and *Tetramorium* with its hard chitinous body, being better able to tackle this minute ant. I introduced a number of workers of *Solenopsis fugax* taken with *Acanthomyops niger* at Sandown into a small plaster observation nest which contained workers of *Acanthomyops flavus* from Portland, and they were all killed by the latter, there being no hiding-place for them in the

Male, female, large and small worker of *Solenopsis fugax*.

Male, female, and worker of *Myrmica sulcinodis*.

Face page 114

plaster nest[31]. It is evidently a much more common and widely distributed species on the Continent than in England, and is found with many different hosts, occurring in fact with nearly all the larger ants[21].

MYRMICA Latreille.

(μύρμηξ, ant.)

Type : **Formica rubra** L. (Latr., 1810).

The genus *Myrmica* is common to the Palaearctic and Nearctic Regions, and comprises robust and intelligent ants, which do not fear the light, nor the open air. They nest under stones, in banks and fallen boughs, etc., and also build earth mounds. They are not very quick in their movements, but are deliberate and sure, going out alone on foraging expeditions, also, however, following each other in files. When these ants carry their fellows, the one that is carried is held by the external edge of one of the mandibles and lies over the back of her carrier with the ventral surface uppermost, the legs and antennae being folded up. They eagerly attend plant-lice out of doors, but also keep a number of species in their nests, and sometimes build special earthen chambers for them ; the sweet excreta of these insects forming the principal part of their food. They are the winter hosts of beetles of the genus *Atemeles*, which they feed, obtaining also a sweet secretion from them.

These ants possess the power of stridulating. The sound is produced by rubbing the post-petiole against the first gastric segment, which is furnished with a file composed of very fine transverse ridges.

The marriage-flight takes place in the autumn, and it commences in the air, but as soon as the couples are united they fall to the ground together, because the female is unable to carry the male when on the wing. Copulation only occupies a very short time, and one female may be mated with three different males in as many minutes. Much has been written about the marriage-flights of these species—Dalglish noticed these ants swarming and dropping like rain on to a greenhouse ; Crawley was on one occasion in a hammock in his garden reading, and thought at first it had begun to rain, by the pattering on the leaves of the trees, caused by *Myrmica* males and females falling down together ; Bond described a combat of ants which occurred near Hornsey in the summer of 1828 ; this, however, was clearly a marriage-flight of *Myrmica*, as he says that they met in mid-air and always fell to the ground in pairs, the one being black and the other red—the former were, of course, the males and the latter the females.

The winged sexes sometimes occur in such numbers as to give the impression of a cloud of smoke in the air, and it was probably a swarm of these ants which caused the people of Coburg in 1866 to think that the tower of the church of St. Maurice was on fire.

Farren-White in 1876 observed a swarm of ants near Stonehouse rising and falling over a small beech tree. The effect of those in the air—gyrating and meeting each other in their course, as seen against the deep blue sky—reminded him of the little dodder, with its tiny clustered blossoms and its network of ramifying scarlet threads, over the gorse or heather at Bournemouth. He noticed the swarm about thirty paces off, and it began to assume the appearance of curling smoke ; at forty paces he could quite imagine the tree to be on fire. At fifty paces the smoke had nearly vanished into thin air. He captured some and found them to be the males of *Myrmica laevinodis*. The males generally die shortly after the marriage-flight, but Lord Avebury kept two males of *Myrmica ruginodis* alive from August till the following Spring, one living till May, and Janet had males living from October till the following April. The females are capable of founding their colonies alone, a fact which was first demonstrated by Lord Avebury, who succeeded in rearing a brood from eggs laid by females in captivity ; the workers reared in this experiment remained about six weeks in the egg; a month in the larval state, and twenty-five to twenty-seven days as pupae. Janet found the times occupied for the development of *Myrmica* workers to be—eggs, twenty-two to twenty-four days ; larvae thirty to seventy-one days ; and pupae eighteen to twenty-two days : total seventy-one to one hundred and seventeen days. In nature larvae are always present in the winter, and the brood is arranged in different heaps according to size ; in observation-nests the eggs and young larvae are generally kept in the dampest chambers, and the pupae in the dryer ones.

Their colonies are of medium size, but sometimes very large and also quite small ones occur, the species varying in this respect. Many females may be present in the same nest, and this is caused by the re-seeking of their own colonies by females which have been fertilized near their own nest, an instance of Wasmann's secondary Pleometrose. Microgynes occur in some colonies, and they may also be present in company with ordinary females, intermediate forms not being found. The males and females are of equal size and are not much larger than the workers, the latter varying very little amongst themselves.

In 1810 Latreille [Cons. Gen. Crust. Ins. 312 No. 445, 437 (1810)] cites *Formica rubra* (L.) F., as the type of the genus *Myrmica*. Westwood [Mod. Class, Ins. **2** Syn. Gen. 83 (1840)]. Girard [Traité Elém. Ent. **2** 1016 (1879)], Bingham [Faun. Brit. India Hym. 2 265 (1903)], and Wheeler [Ann. New York Acad. Sc. **21** 168 (1911)] also all cite *rubra* L. as type, and the last-named author [Ann. New York Acad. Sc. **23** 79 (1913)] adopts Girard's citation.

Emery (Deutsch. Ent. Zeitsch. **1908** 169) points out that Linné's words " pessime nostratum pungens " show that when he described his *Formica rubra* he evidently had before him one, or both, of the

two forms which Nylander later described as *Myrmica ruginodis* and *laevinodis*, since only these two of this group can be described as stinging very badly.

These ants are the " Fourmi rouge " of Huber, and were called " Red Ants " by Gould and other early writers.

We possess six forms which have been considered to be only subspecies by some authors, but I regard them, in company with André, Escherich, and Wheeler, etc., as good though closely allied species.

☿ *Head* oval, rounded posteriorly ; *clypeus* very convex, rounded posteriorly between the bases of the antennae ; *mandibles* broad, terminal border dentate ; *maxillary palpi* six-jointed ; *labial palpi* four-jointed ; *antennae* twelve-jointed, with a three- or four-jointed club (in the British species), *scape* arched or bent at the base, the three last joints of the *funiculus*, taken together, evidently shorter than the rest ; *antennal carinae* widely separated ; *frontal area* depressed, triangular, pointed posteriorly ; *eyes* well developed. *Thorax* rounded anteriorly ; suture between pronotum and mesonotum obsolete ; suture between mesonotum and epinotum moderately distinct, the thorax somewhat sinuate at this point ; *epinotum* armed with two acute spines. *Petiole* cylindrical anteriorly, nodiform posteriorly ; *post-petiole* nodiform, transverse ; *gaster* oval ; *sting* very large. *Legs* : *femora* clavate, *spurs* pectinate.

♀ Characters of the ☿. *Wings* : *fore-wings* with one cubital cell half divided by a transverse vein, and one discoidal cell.

♂ *Head* smaller in proportion than in the ☿ and ♀ ; *clypeus, mandibles,* and *palpi* as in the ☿ and ♀ ; *antennae* thirteen-jointed, *scape* variable in length ; *funiculus* with the first joint shorter than the second, and a not very distinct four- or five-jointed club ; *eyes* very large ; *ocelli* prominent. *Thorax* massive ; *mesonotum* prominent with distinct Mayrian furrows ; *epinotum* only armed with small teeth or tubercles. *Wings* as in the ♀.

Ovum : White, roundish.

Larva : Yellow, narrow anteriorly, broad posteriorly ; the segments gradually increasing in width until quite close to the base. The whole body covered with hairs, which are much more abundant in the young larvae. The first to the sixth abdominal segments are furnished on the dorsum with a pair of long anchor-tipped hairs, which are generally absent in the full-grown larvae. Some of the other long hairs possess a single hook instead of an anchor-tip, some hairs are serrate, and some bifurcate or trifurcate.

Pupa : White, transversely striate ; becoming yellow when mature.

Original description [Latreille Nouv. Dict. d'Hist. Nat. **24** 178–179 (1804)] :—

" II. Antennes inserees très près du bord antérior de la tête.

1. Antennes grossissant insensiblement vers leur extrémité ; premier article faisant presque la moitié de leur longueur, dans les femelles et les mulets ; tête épaisse ; abdomen ovoïde ou conique ; (palpes maxillaires de la longueur au moins des mâchoires, sensibles de quatre à six articles).

A. Premier article des antennes toujours decouvert.

B. Un aiguillon dans les femelles et les mulets.

b. Second anneau de l'abdomen en forme de nœud, séparé du troisième par un profond étranglement ; pedicule de l'abdomen formé de deux nœuds,

** Mandibles triangulaires.

411. Genre Myrmice, *Myrmica*.

Mes F. bossues et mes F. piquantes.

F. rubra } Linn."
F. [illegible]

Formica rubra was described by Linnaeus [Syst. Nat. ed. **10** 580 (1758)] as follows :—

" F. testacea, oculis punctoque sub abdomine nigris."

It is in the twelfth edition [Linn. Syst. Nat. ed. **12** 963 (1767)] that he uses the words—" pessime nostratum pungens."

Table of the Species.

☿ and ♀

1	Scape of antennae abruptly bent at base	2
–	Scape of antennae evenly curved	4
2	Scape of antennae ridged or toothed	3
(1)	Scape of antennae not ridged nor toothed	3 *sulcinodis* Nyl.
3	Scape of antennae with strong transverse ridge at bend	5
(2)	Scape of antennae with more or less developed lateral tooth at bend	4 *scabrinodis* Nyl., and var. *sabuleti* Mein.
5	Scape shorter, epinotal spine shorter, transverse ridge in profile more pointed at apex	5 *lobicornis* Nyl.
	Scape longer, epinotal spine longer, transverse ridge in profile blunter	6 *schencki* Em.
4	Epinotal spines longer than their basal width, transversely striate between	2 *ruginodis* Nyl.
(1)	Epinotal spines not longer than their basal width, smooth between	1 *laevinodis* Nyl.

♂

1	Scape of antennae less than half the length of the funiculus	2
–	Scape of antennae not less than half the length of the funiculus	3
3	Head more strongly punctured, antennae less stout	*schencki* Em.
(1)	Head less strongly punctured, antennae stouter	*scabrinodis* Nyl. and var. *sabuleti* Mein.
2	Scape of antennae abruptly bent at base	*lobicornis* Nyl.
(1)	Scape of antennae evenly rounded	4
4	Frontal area longitudinally striate	*sulcinodis* Nyl
(2)	Frontal area not striate	5
5	Posterior tibiae with long suberect hairs	*laevinodis* Nyl.
(4)	Posterior tibiae with short decumbent hairs	*ruginodis* Nyl.

Myrmica laevinodis Nyl.

Myrmica laevinodis Nylander Acta. Soc. Sc. Fenn. **2** 927[1] 943 Pl. XVIII Fig. 4[2] (1846); Curtis Trans. Linn. Soc. Lond. **21** 213 (1854)[3]. *Myrmica longiscapus* Curtis Trans. Linn. Soc. Lond. **21** 213 (1854)[4]. *Myrmica laevinodis* F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 118 (1855)[5]. *Myrmica longiscapa* F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 122 (1855)[6]. *Myrmica laevinodis* F. Smith Trans. Ent. Soc. Lond. (n.s.) **4** 279 (1858)[7] : Cat. Brit. Foss. Hym. 23 (1858)[8] : Ent. Ann. **1874** 147 Pl. [I] Fig. 3[9]. *Myrmica rubra* race *laevinodis* Forel Denkschr. Schweiz. Ges. Naturw. **26** 271[10] 380[11] 414[12] (1874). *Myrmica laevinodis* Saunders Trans. Ent. Soc. Lond. **1880** 215[13]. *Myrmica incompleta* Provancher Nat. Canad. **12** 359 (1881)[14]. *Myrmica laevinodis* Er. André Spec. Hym. Europe **2** 316 (1881)[15]; Cooke Nat. Yorks **8** 30 (1882)[16]; Wasmann Stett Ent. Zeitg. **51** 299 (1890)[17] : zusam. Nest. gemischt. Kolon. Ameisen **9** (1891)[18]; Dalla Torre Cat. Hym. **7** 110 (1893)[19]; Farren-White Ants' Ways 240 (1895)[20]. *Myrmica rubra* race *laevinodis* Saunders Hym-Acul. 39 (1896)[21]. *Myrmica laevinodis* D. Sharp Cambs. N.H. Insect, **2**

148 (1899)[22]; Escherich Ameise 216 (1906)[23]; Donisthorpe Trans. Leicester Lit.-Phil. Soc. 12 227 (1908)[24]. *Myrmica rubra levinodis* Emery Deutsch. Ent. Zeitschr. **1908** 170[25]. *Myrmica levinodis* Wheeler Journ. Econom. Ent. **1** 337–339 (1908)[26]. *Myrmica rubra* subsp. *levinodis* Wheeler Ants 566 (1910)[27]. *Myrmica laevinodis* Wasmann Biol. Centralb. **30** 454 (1910)[28]. *Myrmica levinodis* Wheeler Journ. New York Ent. Soc. **19** 163 (1911)[29]. *Myrmica laevinodis* Donisthorpe Entom. **44** 390 (1911)[30]; Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 19 (1913)[31]; Donisthorpe Ent. Rec. **25** 5–6 (1913)[32]; Stainforth Nat. **1915** 388[33]. *Myrmica rubra* subsp. *laevinodis* Emery Bull. Soc. Ent. Italiana **47** 119 (1916)[34]. *Myrmica laevinodis* Donisthorpe Ent. Rec. **29** 31 (1917)[35]: **30** 21 (1918)[36]: **31** 1 (1919)[37]. *Myrmica* (*Myrmica*) *rubra* subsp. *laevinodis* Emery Gen. Ins. **174** 39 (1921)[38]; Capra Real. Accad. Sci. Torino **59** 8 (1924)[39]; *Myrmica laevinodis* Donisthorpe **37** 3 (1925)[40]; Finzi Boll Soc. Adriat. Sci. Nat. **29** 83 (1926)[41].

☿ *Reddish yellow, shining, with the head and gaster a little darker above, and the rugosity of the whole body less than in any of the other species. Head* distinctly striate longitudinally, the interstices very slightly punctured; *frontal area* smooth and shining; *antennae: scape* cylindrical at the base, evenly and gradually curved, *club* more or less distinctly four-jointed. *Thorax: epinotal spines* not longer than their basal width, smooth and shining between. *Petiole* slightly punctured, somewhat shining; *post-petiole* feebly wrinkled longitudinally, shining. *Long.* 4–5·5 mm. (4–4·5 mm. *teste Forel.*)

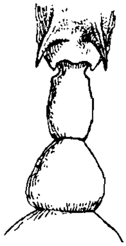


Fig. 63. Epinotum, spines, and pedicel of *Myrmica laevinodis* ☿.

♀ *Reddish yellow; head above, posterior border of the pronotum, a spot at the articulation of the wings, the scutellum, and often a patch on the gaster blackish brown.*

Other characters as in the ☿. *Long.* 5·5–7 mm. (6·5–7 mm. *teste Forel.*)

♂ *Blackish brown, mandibles, antennae, legs and apex of the gaster lighter. Head* finely striate longitudinally; *antennae* with *scape* as long as half the funiculus, gradually curved near the base; *frontal area* smooth and shining, or slightly shagreened. *Thorax* smooth and shining with the exception of the *scutellum* and the *epinotum* anteriorly, which are finely striated. *Petiole* and *post-petiole* smooth and shining. *Long.* 5–5·5 mm.

Original description of *Myrmica laevinodis* Nylander [Acta. Soc. Sc. Fenn. **2** 927 (1846)]:—

"*Operaria*: testaceo-ferruginea sparse flavo-pilosula, capite supra, abdominis dorso in medio et macula ventrali plus minus fuscescentibus; capite et thorace longitudinaliter striatim rugulosis; metanoto spinis binis validiusculis; nodis petioli sublaevibus.

☿ Long. 1¾–2 lin. Sordide testaceo nitidiuscula, oculis parvis prominulis rotundis atris. Ocelli nulli. Caput vertice et fronte parum obscuratis, totum

longitrorsum minus regulariter lateribusque subreticulatim striatulum ; lineâ infra longitudinali impressa nigrescente ab ore ad occiput ducta ; clypeo supra et areâ triangulari frontis politis ; mandibulae subocto-denticulatae, summis apicibus quoque politis ; lamina frontalis marginibus utrinque subrectis, parum arcuatis reflexisque. Antennae scapis ad basin arcuatim parum flexis. Thorax capite angustior, inter mesothoracem et metathoracem parum compressus et in dorso depressum ; metanotum ante spinas subtransversim rugulosum. Nodi petiolares sublaeves, nitidiusculi, sparse pilosi. Abdomen longitudine capitis ovatum, supra visum, parum latius, quam a latere visum ; dorso plus minus infuscato interdum fere toto fusco ; ventre puncto vel macula minori vel majori fusca, interdum obsoleta.

Femina : sordide testaceo-ferruginea sparse flavo-pilosula ; capite, pronoto et scutello abdomineque supra et infra in medio fuscescentibus ; capite thoraceque longitudinaliter striatim rugulosis ; metanoto spinis brevibus validiusculis.

♀ Long. 2½ lin. Sat similis operariae, sed major, obscurior, rugosior. Ocelli distincti. Caput fuscum, mandibulis testaceis apicibus anguste politis fuscis ; antennis testaceis articulorum flagellarium summis apicibus fuscescentibus. Thorax mesonoto, mesopleuris et sterno testaceo-ferrugineis, ceteroquin ferrugineo-fuscescens, spinis metanoti brevibus validiusculis, subdentiformibus. Pedes toti sordide pallide-testacei, pubescentes. Nodi obsolete rugulosi. Abdomen thorace fere longius et nonnihil latius, magis rotundatum quam in ☿, supra et in medio ventris fuscescens. (Alae in nostris speciminibus desunt.)

Mas : nigro-fuscus nitidus sparse flavido-pilosulus, mandibulis tarsisque pallide testaceis ; antennis, trochanteribus, tibiis et apice abdominis plus minus conspicue fusco-pallescentibus ; alis hyalinis obsoletissime cinerascenti-pallescentibus, stigmate obsolete cinerascente.

♂ Long. 2 lin. Fusco-niger nitidus, capite parum opaciori. Caput obsoletissime tenuiter striatulum vel rugulosum, parvum. Palpi et mandibulae testaceae, hae rufescentes apicibus subseptem-denticulatis. Antennae fuscae, flagellis saltem sordide rufescentibus ; scapus tertiam partem totius antennae fere excedens, longitudine prope articulorum 7 sequentium flagelli ; articuli antennarum numero sunt 13. Oculi valde prominuli ; ocelli distincti. Thorax altus nitidus suturis fere omnibus crenatis ; metathorax tuberculo subangulari utrinque. Alae hyalinae inprimis a stigmate versus basin obsoletissime cinereo-pallescentes, nervis et stigmate dilute cinerascenti-pallidis ; area anticarum unica discoidali subrectangulari, nervo radiali nervum transversum apicalem areae primae cubitalis decussante et vel in medio hujus areae desinente vel rarius totam hanc aream percurrente ; anticae long. fere 2¼ lin. Nodi et abdomen nitida. Pedes articulationibus et tarsis totis pallide testaceis, tibiis interdum fusco-pallescentibus, tenuiter longiuscule pilosi."

Habitat.

Myrmica laevinodis occurs in North and Central Europe, further south in mountains, North Asia to East Siberia and Manchuria, also in Japan[25], and a variety, probably introduced, is found in Massachusetts[27]. It is very widely distributed in the British Isles, occurring as far north as Elgin, in Scotland, whence I have also records from Dumfries, Ayr, Haddington, Linlithgow, Fife, Kinross, South, Mid, and North Perth, Easterness, Clyde Isles, the Mid-Ebudes and West Ross ; in Ireland from Antrim, Down, Armagh, Monaghan, Donegal, Meath, Dublin, Kildare, Wexford, Kilkenny, Queen's Co., West Galway, East Galway, Clare, Limerick, North

Tipperary, South Cork, and Kerry ; and in Wales from Glamorgan, Pembroke, and Denbigh : but I have no records in England for South Wilts, Bedford, East Gloucester, Stafford, Salop, Derby, Mid-Lancashire, Mid-west Yorkshire, Cumberland, and Northumberland.

This species prefers to dwell in moist and shady places, nesting under stones, in decayed logs, etc., sometimes making earth mounds,. and also inhabiting fields and cultivated land. Capra records it from the Caves of Pugnetto in Italy[39].

M. laevinodis—with the exception of *M. ruginodis*—is the most warlike of our species and frequent combats occur between different colonies. Forel[10] describes such a combat which he witnessed in Switzerland between two colonies of *M. laevinodis*, their fury being so great that he was unable to separate them, the ants using their stings with great effect.

Dr. Sharp[22] states that it lives in perfect harmony with *Formica rufa*, but this would only be an accidental occurrence, just as were the three colonies—*Myrmica laevinodis*, *Acanthomyops flavus*, and *Formica rufibarbis*—found by Wasmann under the same stone in Dutch Limburg[18]. Their colonies are often large and populous, and sometimes they found branch nests, in the same manner as do some species of the Genera *Formica* and *Acanthomyops*. In April, 1900, at Oddington, near Oxford, Crawley noticed some workers of *M. laevinodis* crossing a path in a shrubbery, carrying larvae. The ants were traced, and found to be conveying larvae from one nest in a rotten stump to another also in a stump. The first stump was nearly covered with moss, which would most likely account for the desertion. Further investigation showed that the colony, which was of enormous size, occupied four nests, all but one of which were in rotten stumps, and workers were continually crossing from one to another. The space occupied by the nests was roughly 12 yds. by 6 yds. Workers from each nest were placed on the others, which they entered without molestation[31]. There is generally a number of fertile females in the same colony ; this is due, as has been before stated, to the females re-seeking their own colony after having been fertilized near their own nest (Wasmann's Secondary Pleometrose[28]).

In June, 1924, I found that many old and hollow willow trees on Sunbury Island harboured colonies of this ant, the workers hunting all over the trunks, and as high as it was possible to see them on the branches[40].

C. Nicholson sent me a number of workers of *laevinodis* which had been taken from the stomach of a green Woodpecker purchased in Leadenhall Market on February 10th, 1919.

The winged forms are to be found in the nests from June to September, but I took four females, each with two or three wings, in a colony under a stone at Bletchington near Oxford on May 17th,

1913, which had no doubt remained in the nest since the previous summer.

The wings often vary in this species; Nylander[2] describes and figures the fore-wing of a male in which the marginal vein entirely divides the cubital cell. B. S. Harwood captured a male at Sydmonton in which the right fore-wing is exactly as in Nylander's figure; and Hallett took another male at Cardiff in which both fore-wings differ from the typical form[32].

Forel records the capture of some very small virgin females in nests at Vaux in 1868[12]—these would be microgynes, of which I found one in a colony which was sent to me by Hallett, taken by Tomlin at Mathon near West Malvern, situated in an old boot. In this case the female had been fertilized; she only measures five mm. in length, and is smaller than her own workers. Wasmann has also found a number of these small females in colonies at Exaeten in Holland.

Joseph Chappell captured a gynandromorphus specimen of *M. laevinodis* in Dunham Park, Cheshire, and presented it to B. Cooke.

It combined characters of male, female, and worker, the right side being entirely worker; on the left side the head being female with an ocellus and antenna exhibiting the female characters; the left side of the thorax is that of the male, the mesothorax exhibiting in front a Mayrian furrow; the epinotum on the left side is destitute of a spine and the legs on the same side are all male.

F. Smith, who recorded and figured this insect as a hermaphrodite, in 1874, stated that it was the first instance of the kind observed in England[9].

Wasmann[17] records a mixed ergatandromorph with only the colour of the head like that of the worker, and the ocelli much smaller and more closely aggregated than in the male. In all other respects the species was a normal male.

On October 11th, 1916, I captured in my garden at Putney a mixed ergatandromorph of this species; my attention being drawn to the ant by the curious "jerky" manner in which it walked. The following is a description of this insect, which was at that date the thirty-fifth gynandromorphous ant recorded.

Head, thorax, first segment of gaster, and a streak on left anterior, right intermediate, and two posterior femora blackish brown; all the rest of the insect pale yellowish red. General appearance worker. Head chiefly ☿, right side slightly more swollen, and right *eye* a little larger than left; two *ocelli* present (median and left lateral); *antennae* twelve-jointed, ☿. *Thorax*: *pronotum* distinct; *mesonotum* high, but not as broad as in ordinary ♂, more swollen on right side, with a short chitinous tubercle similar to the vestigial wings to be found on *pterergates*, bounded at base by a deep hollow, where the scutellum of the ♂ would be; right *Mayrian furrow* present; *epinotum* long as in ☿, furnished with ☿ spine on left side, and ♂ tubercle on right. *Petiole* and *post-petiole* ☿; *gaster* with four segments, slightly more swollen on right side. *Legs* ☿. *Long.* 5 mm.[35].

Wheeler[26] has shown that *M. laevinodis* has recently been introduced into Massachusetts, and gives good reasons to show it is not indigenous in North America. Early in September, 1908, he found a large colony of this ant in the grass at the edge of the Arnold Arboretum, a few steps from the Bussey Institution at Forest Hills, Mass. The workers were attending plant-lice on a few stalks of *Chenopodium album* very near their nest. Some days later he discovered a second colony at the edge of Franklin Park, about a mile from the Arboretum, and early in October he saw a third colony on a lawn near the post office in Jamaica Plain. He remarks that, though by no means common, it is certain that this ant has begun to spread over the country about Forest Hills.

According to Forel *M. laevinodis* understands the cultivation of *Aphidae* better than all the other species of this genus[11], and I have taken the following species in its nests—*Forda formicaria* Heyd., *F. furcata* Theobald, *Pentaphis trivialis* Pass., *Tycheoides setulosa* Pass., and *Schizoneura corni* F.

The undermentioned myrmecophiles have occurred with this ant in Britain[32] :—

Coleoptera : *Atemeles emarginatus* Pk., *A. paradoxus* Gr., *Drusilla canaliculata* F., *Myrmedonia collaris* Pk., and *Staphylinus stercorarius* Ol.

Ichneumonidae : *Pezomachus aquisgranensis* var. *neesii* Först., and *Microcryptus nigro-cinctus* Gr.

Proctotrupidae : *Gonatopus distinctus* Kieff.

Heteroptera : *Myrmedobia coleoptrata* Fall.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic.

Acarina : *Uroplitella donisthorpei* Hull.

Crustacea : *Platyarthrus hoffmanseggi* Brdt.

Myrmica laevinodis Nyl. var. **ruginodo-laevinodis** Forel.

Myrmica rubra race *ruginodo-laevinodis* Forel Den. Schw. Ges. NW. **26** 77–79 (1874)[1]. *Myrmica ruginodo-laevinodis* André Spec. Hym. **2** 319 (1881)[2] ; Forel Ann. Soc. Ent. Belg. **30** 137 (1886)[3]. *Myrmica laevinodis* Nyl. var. *ruginodo-laevinodis* Dalla Torre Cat. Hym. **7** 111 (1893)[4]. *Myrmica laevinodis* v. *laevinodi-ruginodis* Escherich Ameise 216 (1906)[5]. *Myrmica ruginodis-laevinodis* Emery Deutsch. Ent. Zeitschr. **1908** 169[6]. *Myrmica laevinodo-ruginodis* Donisthorpe Ent. Rec. **25** 7 (1913)[7] ; Hallett Cardiff Nat. Soc. Trans. **45** 2 (1913)[8]. *Myrmica ruginodis* var. *laevinodo-ruginodis* Donisthorpe Ent. Rec. **25** 267 (1913)[9]. *Myrmica laevinodis* var. *ruginodo-laevinodis* Donisthorpe Ent. Rec. **26** 138 (1914)[10] : **30** 22 (1918)[11] : **31** 2 (1919)[12]. *Myrmica* (*Myrmica*) *rubra* subsp. *ruginodis* var. *ruginodo-laevinodis* Emery Gen. Ins. **174** 39 (1921)[13]. *Myrmica ruginodis* var. *ruginodo-laevninodis* Finzi Boll Soc. Adriat. Nat. **29** 86 (1926)[14].

Forel[1] pointed out in his admirable work on the Ants of Switzerland that frequent transitions occur between *M. laevinodis* and *M. ruginodis*, in which the length of the epinotal spines, etc., is

intermediate, and for which he proposed the name—*ruginodo-laevinodis*. It seems better, therefore, to include all such intermediate forms, whether they come nearer to *laevinodis*, or to *ruginodis*, under this name.

Central Europe is given as the habitat of this variety by Dalla Torre[4], but it probably occurs wherever *laevinodis* and *ruginodis* are to be found.

Such forms certainly occur in Britain—Hallett sent me specimens from Glamorgan[8], which had the spines shorter than in ordinary *ruginodis*, but the space between rugose, etc.[7]; a similar female specimen was sent to me by S. O. Taylor, who took it at Groby Pool, Leicestershire, in August, 1913, and Hamm has found it at Shotover and Beckley in Oxfordshire, winged females being taken in the former nest on May 5th, 1907. Hodson has found it in Epping Forest; Peacock at Cadney[12] in North Lincoln; Nixon at Whalley in Lancashire; and Phillips at Ballinalacker, Co. Clare. I have taken it in the New Forest, and I found a colony on Lundy Island[9], in which the length of the spines and the rugosity of the whole body is intermediate between *laevinodis* and *ruginodis*, the space between the spines being feebly striate transversely. A small deälated female taken in this colony only measures 5.5 mm. It also occurs at Putney, where I have captured workers on a fence near my house; and in Richmond Park, where I witnessed a marriage-flight at 1.30 p.m. on August 21st, 1917. One couple was joined together on the ground, and many males and a few females were running about and rising into the air.

On July 13th, 1917, a colony of this variety was found in the churchyard at Broadwater near Worthing. The workers were hunting about on the stone path, the nest was situated in the grass above it, the wood-louse *Platyarthrus hoffmanseggi* being present in the nest. On a subsequent visit, on July 21st, a single male was taken from this colony, which proved to be a gynandromorphous specimen. It is a mixed gynandromorph, nearly entirely normal male in appearance. The left antenna, however, is only 12-jointed and female in shape; the right being 13-jointed, and normal male. The gaster of five visible segments (♂) is somewhat twisted, and the first segment on the right side is rounder than on the left; the genitalia being scarcely visible even when viewed from beneath. This is the thirty-sixth gynandromorphous ant recorded[11].

Forel[3] records finding a colony of *M. ruginodo-laevinodis* which was leaving its old nest, and proceeding to a new one in the moss. The ants were walking very fast, carrying their fellows and their brood, and he noticed that the males being carried were grasped by the thorax with their legs and antennae folded up, in the same way that the pupae are carried by the workers.

Wallis-Kew captured two specimens of the beetle *Atemeles*

emarginatus var. *nigricollis* Kr. in a nest of this variety situated under a large stone at Countisbury near Lynmouth in Devonshire in October, 1912[9].

Myrmica ruginodis Nyl.

Myrmica ruginodis Nylander Acta. Soc. Sc. Fenn. **2** 929 (1846)[1]. *Myrmica diluta* Nylander Acta. Soc. Sc. Fenn. **3** 41 (1849)[2]. *Myrmica vagans* Curtis Trans. Linn. Soc. Lond. **2** 213 (1854)[3]. *Myrmica ruginodis* F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 116 (1855)[4]: **4** 279 (1858)[5]: Cat. Brit. Foss. Hym. 20 (1858)[6]; Elwin Science Gossip **1871** 245–248[7]; H. Müller Befrucht. d. Blumen 464 (1873)[8]. *Myrmica rubra* race *ruginodis* Forel Denkschr. Schweiz. Ges. Naturw. **26** 142[9] 225[10] 380[11] (1874). *Myrmica ruginodis* Elwin Science Gossip **1874** 58–60[12]; Swinton Ent. Mo. Mag. **14** 187 (1878)[13]; Lubbock Journ. Linn. Soc. Zool. **14** 270 (1878)[14]; Saunders Trans. Ent. Soc. Lond. **1880** 214[15]; Parfitt Ent. Mo. Mag. **18** 43 (1881)[16]; Er. André Spec. Hym. Europe **2** 317 (1881)[17]; Lubbock Ants, Bees, Wasps 32 (1882)[18]; Farren-White Ants' Ways 239 (1885)[19]. *Myrmica rubra* race *ruginodis* Saunders Hym.-Acul. 40 (1886)[20]. *Solenopsis fugax* Provancher Nat. Canad. **17** 22 (1886)[21]. *Myrmica ruginodis* Wasmann Stett. Ent. Zeitg. **51** 306 308 (1890)[22]: zusam Nest. u. gemischt. Kolon. Ameisen 16–17 (1891)[23]; Bignell Ent. Mo. Mag. **28** 135 (1892)[24]; Dalla Torre Cat. Hym. **7** 115 (1893)[25]; Wasmann Biol. Centralb. **13** 39 (1893)[26]; Morice Ent. Mo. Mag. **30** 260 (1894)[27]. **Stenamma westwoodi* Malloch Fauna, Flora, Geol. Clyde Area 219 (1901)[28]. *Myrmica ruginodis* Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 227 (1908)[29]. *Myrmica rubra ruginodis* Emery Deutsch. Ent. Zeitschr. **1908** 171[30]. *Myrmica ruginodis* Donisthorpe Entom. **44** 390 (1911)[31]; Morley Proc. R. Irish Acad. **31** (24) 3 (1911)[32]; Donisthorpe Ent. Rec. **25** 6–8[33] 96[34] (1913); Beare Ent. Rec. **25** 258 (1913)[35]. *Myrmica* (*Myrmica*) *rubra* subsp. *ruginodis* Emery Bull. Soc. Ent. Italiana **47** 119 (1916)[36]: Gen. Ins. **174** 39 (1921)[37]. *Myrmica ruginodis* Donisthorpe Ent. Rec. **34** 81 (1922)[38]: **37** 3 (1925)[39]; Finzi Boll. Soc. Adriat. Sci. Nat. **29** 85 (1926)[40].

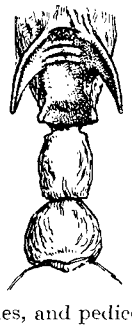


Fig. 64. Epinotum, spines, and pedicel of *Myrmica ruginodis* ☿.

☿ *Reddish yellow; sometimes much darker, the head pedicel and gaster being blackish brown. Very like the preceding but on the average larger, the body being always more rugose.*

Fig. 65. Antenna of *Myrmica ruginodis* ☿.

Head a little broader than in *laevinodis*. *Thorax : epinotal spines* longer than their basal width, transversely striate between. *Petiole* and *post-petiole* longitudinally wrinkled, the latter not, or scarcely, shining. *Long*. 4·5–6 mm. (5–5·5 mm. *teste Forel*.)

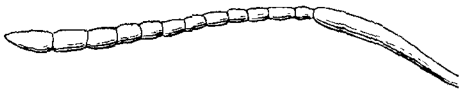


Fig. 66. Antenna of *Myrmica ruginodis* ♂.

♀ *Very like* laevinodis, *sometimes a little darker ;* characters as in the ☿. *Long*. 5·4–6·5 mm. (6·5–7 mm. *teste Forel*.)

♂ *Very like* laevinodis, *a little larger on the average ; the antennae appear to be a little longer, the sculpture a little stronger, and the epinotal tubercles more pronounced, but* laevinodis *varies in these particulars. Tibiae* furnished with short decumbent hairs. *Long*. 5–6 mm.

Original description of *Myrmica ruginodis* Nylander [Acta. Soc. Sc. Fenn. **2** 929 (1846)] :—

" *Operaria : testaceo*-ferruginea *sparse flavo-pilosula ; capite supra*, abdominis dorso in medio et macula ventrali plus minus fuscescentibus ; capite thoraceque longitudinaliter striatim rugulosis ; metanoto spinis binis validiusculis longis ; nodis petioli rugosis.

☿ Long. 2 lin.—parum ultra. Simillima praecedenti, sed paulo major, rudius fere rugosa, metanoto ante spinas longitudinaliter rugoso, spinis longioribus et nodis longitudinaliter confuse, sed non profunde rugosis. Clypeus supra sat late politus. Cetera ut in praecedente.

Femina : testaceo-ferruginea sparse flavido-pilosula ; capite supra, abdominis dorso medio et macula ventrali plus minus fuscescentibus ; capite thoraceque longitudinaliter striatim rugulosis ; metanoti spinis longiusculis ; alis hyalinis obsoletissime cinerascenti-pallescentibus, stigmate distincto cinereo-fuscescente.

♀ Long. fere 2½ lin. Simillima feminae praecedentis, et jam colore et spinis metathoracis duplo longioribus distincta. Caput supra fuscescens, clypeo fusciori, oculis atris ; infra pone oculos, mandibulis antennisque testaceo-ferrugineis ; mandibulae apicibus parum fuscescentibus. Striae clypei magis confusae quam in praecedente. Thorax metanoto et pleuris obsoletissime, scutello vero distinctius fuscescentibus ; spinis longiusculis. Alae ut supra ; anticae long. 2½ lin. Pedes toti pallide testaceo-ferruginei. Nodi sicut in ☿.

Mas : nigro-fuscus nitidus parcissime tenuiter flavido-pilosulus ; mandibulis, articulationibus pedum et tarsis testaceo-pallescentibus, antennarum flagellis apiceque abdominis obscure rufescentibus.

♂ Long. 2½ lin. Mari praecedentis speciei simillimus, at paullo major, robustior, capite inprimis conspicue majori, alarum stigmate distinctiori fusciori, pedibus longe nudioribus. Caput nitidum subtiliter obsolete rugulosum ; clypeus politus aequalis convexiusculus. Alae ut in ♀, anticae long. 2⅓ lin. ; pedes tenuiter pubescentes, subnudi."

Habitat.

The distribution of *Myrmica ruginodis* in Europe is similar to that of *M. laevinodis*, but it does not appear to range so far east in Asia[30]. It is very widely distributed in the British Isles, occurring

as far as Caithness in the extreme north of Scotland, and is probably to be found all over the country. Morice recorded it from the Shetland Isles as the only ant he could find there[27], and all ants sent to me from the Shetlands by Waterston have proved to be the same ; it is also abundant on St. Kilda.

In Wales it has been found in Glamorgan, Brecon, Pembroke, Merioneth, Carnarvon, Denbigh, and Anglesey, and in Ireland in Derry, Antrim, Down, Armagh, Monaghan, Donegal, Louth, Dublin, Kildare, Carlow, Kilkenny, Queen's Co., Wexford, Westmeath, West Mayo, West and East Galway, Clare, North Tipperary, Waterford, North Cork, South Cork, and Kerry ; but I have no records in England for North Somerset, South Wilts, North Hants, Herts, Bedford, East Gloucester, Salop, Derby ; and in Scotland for Kircudbrightshire, Wigtown, Selkirk, Roxburgh, North Perth, Forfar, South and North Aberdeen, Banff, the Clyde Isles and South and North Ebudes, East Ross and West Sutherland.

Myrmica ruginodis occurs in uncultivated places, nesting under stones, in rotten stumps, at the edges of woods and roads, etc., and appears to require less moisture than *laevonidis* (though Fryer sent specimens to me from a colony he had discovered in June, 1912, in Woodwalton Fen, the nest being situated in the peat, and Box found a colony nesting in sphagnum in Staffordshire, in June, 1916), and according to Forel[11] both these species are entirely missing in arid places.

Praeger found specimens of this ant in a Puffin's nest on the Bills Rocks near Clare Island in June, 1910[32].

André points out that *ruginodis* is often found in higher latitudes than *laevinodis*, reaching the alpine regions[17], and Forel says it extends to the region of the fir trees, recording it from Siebenbrunnen at 1460 metres, and Dischmathal at over 1600 metres[10]. Hull found colonies up to 1900 ft., at West Allendale in March, 1912[33], Johnson up to 1500 ft., on Clare Island[32], and I have taken it on Snowdon.

Occasionally its colonies are found in close proximity to other ants' nests—Wheeler, when in England in August, 1912, observed a colony close to nests of *M. laevinodis* and *M. scabrinodis* on the hill at the back of Wordsworth's cottage at Grasmere, Morley found it nesting under the same stone as *Acanthomyops flavus* at Killaloe in 1913, and I discovered it in company with the latter species in the same earth mound at Luccombe Chine in August, 1913.

Wasmann[23] records that in July, 1886, he found colonies of *M. ruginodis* inhabiting the nests of the wood-ants *Formica pratensis*, and *F. rufa*. In the first case most of the *pratensis* had deserted their nest, but in the other it was quite different—here the *rufa* colony was a very populous one and the *ruginodis*, which

consisted of a fairly strong colony with about one hundred larvae and pupae, had established its nest in a small hollow in the upper part of the former's hillock. They had probably selected this situation to take advantage of the higher temperature they would obtain there to bring up their brood. At first there would have been some fighting between the two species, but eventually, as is the case with strange ants which nest under the same stone, etc., they would become indifferent to each other, and leave each other alone.

M. ruginodis, in common with *laevinodis*, is a warlike ant and stings fiercely, and Bignell[24] records what he took to be an instance of its making war on its own species. He states that :—" Rambling near the border of Dartmoor, a few miles from Plymouth, on the 10th instant (April, 1892), I caught sight of *Myrmica ruginodis* carrying something that I could not at first well define ; standing quietly a few moments I saw many others loaded in the same manner. I captured one, and, to my surprise, I found it was another of the same species it was carrying. I have no doubt a raid had been made on a smaller colony, and the victorious party were conveying them off to strengthen their home. The prisoner was grasped by the throat, the abdomen turned over on the top of the head of the carrier."

On this occasion, however, it is certain that the ants were only moving to another nest, carrying their fellows, as is their habit. No strange ant would allow itself to be quietly carried in this manner, and as I have before shown a *Myrmica* always lies over the back of its fellow when carried, and it would have been the jaws that were grasped, not the throat. As an instance of tenacity of life in this species, a specimen of *M. ruginodis* may be mentioned, which C. Best Gardner had in his possession in 1913, which lived without a head for twenty-one or twenty-two days.

Sometimes colonies of *ruginodis* occur in which all the individuals are very dark in colour—I found two such colonies on June 14th, 1911, on the mountains at Rannoch, in which some of the workers were nearly black.

It attends and keeps *Aphidae*, but also feeds on other insects, and will eat honey in captivity. H Müller[8] records the capture of both *M. ruginodis* and *laevinodis* in the flowers of *Chrysosplenium* and *Compositae*, where they were no doubt seeking the nectar of the flowers.

Elwin[7] mentions that a colony he kept in captivity, fed on " blue bottles " and also devoured the remains of a dead sparrow. On September 1st, 1914, I observed an isolated deälated female *ruginodis* at Weybridge, which was carrying a fly in its jaws. They also collect seeds—when staying with Crawley in July, 1912, at Seaton in Devon, he called my attention to the fact that

in his garden the seeds of the blue cornflower (*Centaurea cyanus*) were collected by workers of *M. ruginodis* and carried to their nest, which was situated just near the front door, the ants bringing the seeds from quite a long distance[34]. They probably devour the elaiosome of the seeds, as Sernander has shown that when it is removed, the seeds are not nearly so attractive to ants.

The stridulating of *ruginodis* has been noticed by Swinton[13] and Wasmann[26]. The former observer, having seen specimens of this ant attending *Aphidae* on thistle heads at Guildford in July, 1877, captured some of them and covered them with an inverted wine-glass. He writes :—" The weather was hot and sultry, and these *Myrmicae* were probably irascible ; for they had not been long left to themselves, when a puny individual was observed, placed head downwards, at the side, and near the inverted edge of the glass, rapidly vibrating its abdomen vertically from the pedicle, and simultaneously giving out a continuous singing sound, resembling in tone and intensity the sharp whining of the little dipteron, *Syrilla pipiens*."

Wasmann having put a strong section of a *ruginodis* colony into an empty glass vessel, the day being warm, the ants were very excited, moving the gasters up and down, and he noticed a chirping noise, which reminded him of the sound caused by the Iris pod beetle, *Mononychus pseudacori*.

The winged forms are to be found, and the marriage-flights occur, at the same times as in *laevinodis*. Beare records a swarm of this species at Nethy Bridge on August 15th, 1913, at 2.30 p.m., the air temperature being 75° F.[35], Evans observed males and females floating in Loch Glow, Kinross, on September 11th, 1909, and on October 5th, 1925 (a warm, sunny and windless day), Day observed hundreds of winged ants in the air on the top of Saddle-back, Cumberland (2847 ft.) ; those he captured proved to be this species. On April 30th, 1912, I found three small females partly winged, under a stone, in a colony of *ruginodis* at Hynish in the Isle of Tiree[33]. S. O. Taylor captured a winged microgyne of this species at Wakerley Wood, Northamptonshire, on August 17th, 1915. Wasmann took a number of winged females in a nest of *ruginodis* at Vorarlberg, Feldkirch, in August, 1890, which were smaller than the workers of the same colony[22].

The same observer records finding a large worker with the head more like that of a female, the rest of the body, however, being ergatoid, in a colony at Exaeten in Holland[22].

On July 28th, 1919, I observed an ant of this species which was walking about on the heath at Weybridge, and although to the naked eye it appeared to be normal, yet there was something about its movements which caused me to bottle it. Under the microscope there can be seen a short growth projecting from the basal third of

the inner side of the scape of the left antenna ; a tiny point occurring at the end of the projection. It may possibly be a portion of a half-formed second scape ; the point at the end being the spot whence the funiculus would arise. This growth may be due to an injury caused by pressure, or otherwise, in an earlier instar ; the wound being the starting-point of a super-regeneration of a second scape[38].

Forel describes a frontal gynandromorph taken by Frey-Gessner " sur le col du Susten," the body being perfectly symmetrical.

It is rather a male, as the gaster has five segments in addition to the petiole and post-petiole and the external genitalia are male. The epinotum has only two tubercles instead of spines, but the eyes are much smaller than those of the male, and hence more like the female. The head is also a little larger than the head of a male, but both its form and colour are intermediate between the two sexes. Antennae thirteen-jointed as in the male, but in colour and form recalling the antennae of the female. There are also two distinct red bands on the anterior portion of the mesonotum, which are never found in the male. Sculpture of head and epinotum more rugose and less shining than in the male[9].

The first experiment in which ants were brought up from eggs, laid in captivity, was carried out by Lord Avebury with this species. He writes :—" On August 14th, 1876, I isolated two pairs of *Myrmica ruginodis* which I found flying in my garden. I placed them with damp earth, food, and water, and they continued perfectly healthy through the winter. In April one of the males died, and the second in the middle of May. The first eggs were laid between April 12th and 23rd. They began to hatch the first week in June, and the first larva turned into a chrysalis on the 27th ; a second on the 30th ; a third on July 1st, when there were also seven larvae and two eggs. On the 8th there was another egg. On July 8th a fourth larva had turned into a pupa. On July 11th I found there were six eggs, and on the 14th about ten. On the 15th one of the pupae began to turn brown, and the eggs were about 15 in number. On the 16th a second pupa began to turn brown. On the 21st a fifth larva had turned into a pupa, and there were about 20 eggs. On July 22nd the first worker emerged, and a sixth larva had changed. On the 25th I observed the young worker carrying the larvae about when I looked into the nest ; a second worker was coming out. On July 28th a third worker emerged and a fourth on August 5th. The eggs appeared to be less numerous, and some had probably been devoured."[14].

On September 28th, 1912, I found two *ruginodis* deälated females at Wellington College, side by side in a small hole in the ground, and this suggests that on occasion two females may join together in founding a colony.

Elwin[12] found larvae and pupae present in a colony in his possession after three years, there being no female present. These

would have hatched from eggs laid by the workers ; he mentions that no more females were bred.

I have taken the following *Aphidae* in *ruginodis* nests :—*Forda formicaria* Heyd., *Tycheoides setariae* Pass., *Brysocrypta lactucaria* Pass., *B. ranunculi* Kalt., *Schizoneura corni* F., *Tetraneura ulmi* Geoff., *Aphis plantaginis* Schr., and *A. heraclei* Koch. Parfitt recorded Hypopi (the young of Acari) on the gasters and antennae of ants of this species in a nest near Exeter[16].

The following other myrmecophiles have been found with this ant in Britain[33].

Coleoptera : *Atemeles emarginatus* Pk., *Drusilla canaliculata* F., *Lamprinus saginatus* Gr., *Staphylinus stercorarius* Ol., and *S. latebricola* Gr.

Ichneumonidae : *Pezomachus aquisgranensis* Först.

Braconidae : *Pachylomma buccata* Nees.

Proctotrupidae : *Ceraphron myrmicarum* Kieffer, and *Gonatopus bicolor* Hal.

Diptera : *Microdon mutabilis* L., larva, *Apiochaeta* (=*Phora*) *conformis* Wood, *A. femorata* Wood, and *Pseudacteon brevicauda* Schmitz.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic., and *Sminthurus caecus* Tull.

Acarina : *Laelaps* (*Hypoaspis*) *myrmecophilus* Berl.

Crustacea : *Platyarthrus hoffmanseggi* Brdt.

Myrmica ruginodis Nyl. var. **sulcinodo-ruginodis** Emery and Forel.

Myrmica rubra race *sulcinodis* Nyl. (et varr. *ruginodis* ? et *sulcinodis-ruginodis* ?) Forel Den. Schw. Ges. NW. 26 77 (1874)[1]. *Myrmica sulcinodo-ruginodis* Emery and Forel Mitt. Schweiz. Ent. Gessell. 5 461 (1879)[2] ; Er. André Hym. Europe 2 319 (1881)[3]. *Myrmica ruginodis* Nyl. var. *sulcinodo-ruginodis* Dalla Torre Cat. Hym. 7 116 (1893)[4]. *Myrmica sulcinodis-ruginodis* Emery Deutsch. Ent. Zeitschr. 1908 174[5]. *Myrmica sulcinodis* var. *sulcinodo-ruginodis* Emery Gen. Ins. 174 42 (1921)[6] ; Finzi Boll. Soc. Adriat. Sci. Nat. 29 88 (1926)[7].

Forel[1] states that certain varieties of *Myrmica sulcinodis* are so near to *M. ruginodis* that it is almost certain that intermediate forms exist between these two races.

I have seen workers, from a colony, discovered at Leith Hill by Arnold on April 18th, 1909, which may be said to represent this variety.

In these specimens the frontal area is slightly longitudinally striate (which is more pronounced in some individuals than in others), and the scape of the antennae is slightly more bent at the base than in typical *ruginodis*, otherwise the shape, colour, and general appearance are that of the latter, to which species they are more nearly related.

Myrmica sulcinodis Nyl.

Myrmica sulcinodis Nylander Acta. Soc. Sc. Fenn. **2** 934 (1846)[1]: **3** 27 (1849)[2]. *Myrmica perelegans* Curtis Trans. Linn. Soc. Lond. **21** 214 (1854)[3]. *Myrmica sulcinodis* Mayr Verh. Zool. Bot. Ver. Wien **5** 409 (1855)[4]; F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 119 (1855)[5]: **4** 279 (1858)[6]: Cat. Brit. Foss. Hym. 24 (1858)[7]. *Myrmica rubra* race *sulcinodis* Forel Denkschr. Schweiz. Ges. Naturw. **26** 76[8] 226[9] 381[10] (1874). *Myrmica sulcinodis* Parfitt Trans. Devon Assn. Sc.-Art. **12** 515 (1880)[11]; Saunders Trans. Ent. Soc. Lond. **1880** 215[12]; Er. André Spec. Hym. **2** 317 (1881)[13]; Saunders Ent. Mo. Mag. **22** 116 (1885)[14]; Dalla Torre Cat. Hym. **7** 117 (1893)[15]; Farren-White Ants' Ways 240 (1895)[16]; Wasmann Biol. Centralb. **15** 609 (1895)[17]. *Myrmica rubra* race *sulcinodis* Saunders Hym.-Acul. 40 (1896)[18]. *Myrmica sulcinodis* Johnson Irish Nat. **6** 57 (1897)[19]. *Myrmica rubra* râce *sulcinodis* Malloch Fauna, Flora, Geol. Clyde Area 219 (1901)[20]; Vic. Hist. Berks **1** 76 (1906)[21]; Vic. Hist. Cornwall **1** 185 (1906)[22]; *Myrmica rubra* v. *sulcinodis* Saunders Ent. Mo. Mag. **42** 61 (1906)[23]. *Myrmica sulcinodis* Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 228 (1908)[24]; Emery Deutsch. Ent. Zeitschr. **1908** 173[25]; Ellis and Martineau Ent. Rec. **20** 56 (1908)[26]. *Myrmica rubra* race *sulcinodis* Morley Irish Nat. **19** 185 (1910)[27]. *Myrmica sulcinodis* Donisthorpe Ent. Rec. **23** 11 (1911)[28]; Entom. **44** 390 (1911)[29]; Morley Proc. R. Irish Acad. **31** (24) 3 (1911)[30]; Orr Irish Nat. **20** 76 (1911)[31]; Donisthorpe Ent. Rec. **24** 5 (1912)[32]; Evans Scot. Nat. **1912** 107[33]; Donisthorpe Ent. Rec. **25** 42 (1913)[34]; Hallett Cardiff Nat. Soc. Trans. **45** 2 (1913)[35]; Haines Entom. **47** 129 (1914)[36]; Emery Bull. Soc. Ent. Italiana **47** 119 (1916)[37]; Donisthorpe Ent. Rec. **31** 1 (1919)[38]; *Myrmica* (*Myrmica*) *sulcinodis* Emery Gen. Ins. **174** 42 (1921)[39]. *Myrmica sulcinodis* Finzi Boll. Soc. Adriat. Sci. Nat. **29** 86 (1926)[40]. *Myrmica wesmaeli* Finzi Boll. Soc. Adriat. Sci. Nat. **29** 98 (1926)[41].

☿ *Colour variable; nearly black to all red, in some specimens the thorax and pedicel are pale red, the head and gaster being blackish brown. In the lighter coloured individuals the posterior part of the head is lighter. The mandibles are always of a lighter or darker yellow with the teeth fuscous.*

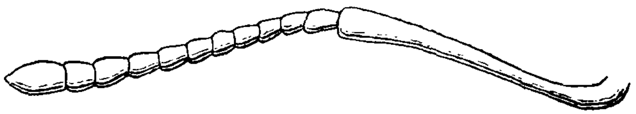


Fig. 67. Antenna of *Myrmica sulcinodis* ☿.

Head strongly striate longitudinally, which together with transverse ridges form a network at the sides and base; *clypeus* rounded and convex; *antennae* abruptly bent near the base, with a three-jointed club; *frontal area* longitudinally striate. *Thorax* coarsely striate longitudinally; *epinotal spines* strong, fairly long and somewhat convergent, the space between smooth and shining. *Petiole* and *post-petiole* coarsely rugose longitudinally, the former high and angled anteriorly, the anterior surface in profile forming an almost straight line to the junction with the thorax. *Long.* 4·3–6 mm.

♀ *Colour and characters as in the* ☿, *the sculpture being a little stronger.*

Thorax: mesonotum deeply striate longitudinally. *Long.* 5·5–6·8 mm. (6·5–7 mm. *teste Forel.*)

♂ *Blackish brown, shining; mandibles, base and apex of the scape and funiculus of the antennae and the joints of the legs, and sometimes the extremity of the gaster, yellowish; tarsi yellow.*

Head longitudinally striate with a faint, smooth, central channel; *frontal area* longitudinally striate; *scape* of antennae about half the length of the

funiculus, gradually curved at the base ; club of antennae five-jointed, the first joint of which is not so broad as the four following joints. *Thorax* striate longitudinally, somewhat shining. *Petiole* finely striate ; *post-petiole* smooth and shining. *Long.* 5·5–6·5 mm.

Original description of *Myrmica sulcinodis* Nylander [Acta. Soc. Sc. Fenn. 2 934 (1846)] :—

" *Operaria :* sordide rubida sparse flavo-pilosula, capite et abdomine fusco-nigrescentibus, mandibulis antennisque pallide rufescentibus ; capite, thorace et petiolo longitudinaliter striatim profunde exaratis ; antennis scapo ad basin parum curvato ; metanoti spinis longis.

☿ Long. circ. 2 lin. Omnino similis praecedenti, tantum pallidior, antennarum scapis et nodis aliter formatis. Area frontalis obsoleta, striis percurrentibus. Laminae frontalis marginibus infra parum minus dilatatis. Antennae ad basin scapi parum curvatae, magis tamen quam in *M. laevinodi.* Dentes metanoti fere longiores subulati. Nodi longitudinaliter sulcati, sulcis rudibus sub-duodecim in utroque sat ordinatis (nec confusis ut in praecedente).

Femina : sordide fusco-rubescens sparse flavido pilosula, capite et abdomine fusco-nigrescentibus, mandibulis antennisque sordide rufescentibus, pedibus ferrugineo-pallescentibus ; capite, thorace et petiolo profunde longitudinaliter striatim exaratis ; antennis scapo ad basin parum curvato ; metanoti spinis longis.

♀ Long. 2½ lin. Similis iterum feminae praecedentis, iisdemque notis a ☿ ab ☿ ejusdem dignoscenda. Characteres capitis ut in ☿. Spinae metanoti longae subulatae, obsolete curvatae. Nodi lateribus imprimis profunde longitrorsum ordinate sulcatis. (Alae desunt.) "

Habitat.

According to Professor Emery *Myrmica sulcinodis* occurs in North Europe and North Asia, direct east to Manchuria and Amurland ; further south it is a mountain species : Pyrenees, Alps, Apennines, Balkans, and Caucasus[25].

Its distribution in our islands is as follows :—

Cornwall[22].

Devon, S. : Lustleigh Cleave and Sandy Gate, St. George's Clist (*Parfitt*)[11].

Dorset : Wareham (*Dale*)[16] ; Bloxworth (*Dale*)[18] ; Studland (*Dale*)[18] ; Parley Heath (*Dale*)[18] ; Ringstead (*Haines*)[36].

Hants, S. : Bournemouth (*Curtis*)[3] ; New Forest (*Hamm*)[32] ; **Hants, N. :** Fleet (*E. A. Butler*).

Surrey : Chobham (*Saunders*)[14] ; Woking (*Saunders*)[18] ; Weybridge (*Donisthorpe*).

Essex, S. : Epping Forest, Chingford (*E. A. Butler*).

Berks : Wellington College (*Barnes*)[21] ; Newbury (*Hamm*).

Worcester : Bewdley (*Ellis* and *Martineau*)[26].

Glamorgan : Cwrt-yr-ala (*Hallett*)[35].

Anglesey : Holyhead (*J. C. Dale*)[16].

Yorks, Mid. W. : Sherburn (*F. Smith Coll.*).

Ayr : Irvine Moor (*Dalglish*)[20]

Edinburgh : Bavelaw Moss near Balerno (*Evans*)[33]
Perth, Mid. : Rannoch (*Donisthorpe*)[32].
Aberdeen, S. : Braemar (*Donisthorpe*)[28].
Easterness : Nethy Bridge (*Donisthorpe*)[32]; Nairn (*Yerbury*)[23].
Antrim : Belfast Cemetery (*Orr*)[31].
Armagh : Poyntzpass (*Johnson*)[19].
Donegal : Tory Island, Cratlay Woods, and Glenveagh (*Morley*)[27].
Mayo, W. : Achill Sound (*Johnson*)[32].

The male of this elegant species was unknown to Nylander when he described the worker and female in 1846[1], and Smith states, in 1855[5], that it is described by himself for the first time, although he quotes Curtis's paper in which the latter described the male, as well as the female and worker, from a colony under a stone on a heath near Bournemouth, under the name of *Myrmica perelegans*[3].

M. sulcinodis chiefly nests under stones, its colonies being only of moderate size, and its habits appear to be intermediate between those of *M. ruginodis* and *M. scabrinodis*.

Farren-White points out that it has been said to raise a mound like the turf dwellings of *Acanthomyops flavus*, but according to his experience its nest is but very slightly elevated above the surface of the soil[16].

Nylander[2] and Mayr[4] both give mountains for its habitat; and Forel[9] and André[13] affirm that it is exclusively an alpine species. The former observer says that it ranges to nearly as high an altitude as does *Formica fusca*, and is abundant in the highest parts of the Engadine, nesting under stones on high pastures up to the region of the fir trees[9].

On May 23rd and 25th, 1914, Dr. Chapman found workers attending the larvae of the "Blue Butterfly" (*Polyommatus eros* Ochs.), at Le Lautaret at an elevation of 7000 ft. odd.

Its habits are certainly different in the British Isles—it is true that I have found it under stones on mountains at Rannoch[32] and Braemar[28], though only at a moderate height, but it is more abundant down south, on heaths and commons, such as at Woking, Bournemouth, and in the New Forest. The sexes swarm in August and September; Saunders records finding an isolated female, the only time he ever met with this sex, running on the ground at Chobham in August, 1885[14], and I took deälated females in sand-pits in the New Forest on May 21st and June 7th, 1908. I found male and female pupae in a colony under a stone on a mountain at Rannoch on June 14th, 1911, and also in another situated under a piece of timber on the sandy bank of the Nethy, at Nethy Bridge, on June 21st, 1911, which I took home with some of their workers, and from which the winged forms emerged in July[32].

Wasmann[17] records finding, in August, 1891, in a colony of this species at Arlbergpass at a height of 1800 metres, an individual

in which the shape of the thorax and size of the body was that of a worker, the gaster, however, being as well developed as that of a fertilized female, and there did not appear to be any other queen, or female, in the nest.

Among a number of males, females, and workers labelled Bloxworth Heath, in the collection of the late Rev. O. Pickard-Cambridge, I detected an interesting ergatandromorph, which Mr. A. W. Pickard-Cambridge generously gave to me. It may be described as follows :—

Head reddish brown, mandibles yellow, antennae and cheeks red, thorax light yellowish red, petiole and post-petiole red, gaster partly red, partly dark brown, legs red.

Whole body except gaster mostly normal ☿. *Head* less rugose than in normal ☿, thorax with rugose striae not longitudinal, but slanting on *prothorax*, and transverse and rounded on *mesothorax*. *Epinotal* spines slightly shorter than in normal ☿. *Gaster* deformed looking, triangular ; first segment divided into three parts, the section on right side rounded, blackish brown, very shining, and covered with hairs, the centre section only visible on dorsal surface, small, light brown and glabrous, the left section lighter to darker brown with a few hairs continued over most of the ventral surface where it meets the section from right side. The next three segments on dorsal surface are light brown and shining, with rows of hairs near apex, and two small parts of the ventral segments on left side. The fourth segment appears to form a continuous ring, which is slightly split at apex, and from it a bit of a fifth segment is visible. One *stipes*, and a *sting* are extruded from the latter segment. *Long.* 5·5 mm.[38]

The following myrmecophiles have occurred with this species in Britain :—

Coleoptera : *Atemeles emarginatus* Pk., and *Drusilla canaliculata* F.[34].

Collembola : *Cyphodeirus* (=Beckia) *albinos* Nic.

Crustacea : *Platyarthrus hoffmanseggi* Brdt.

Myrmica scabrinodis Nyl.

Myrmica caespitum Zetterstedt Insect. Lappon. 1 450 (1838)[1]. *Myrmica scabrinodis* Nylander Acta. Soc. Sc. Fenn. 2 930 (1846)[2] : 1052 (1846)[3]. *Myrmica rubra* Curtis Trans. Linn. Soc. Lond. **21** 213 (1854)[4]. *Myrmica scabrinodis* F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 115–116 (1855)[5] : **4** 279 (1858)[6] : Cat. Brit. Foss. Hym. 21 (1858)[7]. *Myrmica rubra* race *scabrinodis* Forel Denkschr. Schweiz. Ges. Naturw. **26** 76[8] 225[9] 381[10] (1874). *Myrmica scabrinodis* Saunders Trans. Ent. Soc. Lond. **1880** 215[11] ; Er. André Spec. Hym. Europe 2 319 (1881)[12] ; Lubbock Ants, Bees, Wasps 27 (1892)[13] ; Angus Proc. NH. Soc. Glasgow (n.s.) **1** XVIII (1884)[14] ; Wasmann Stett. Ent. Zeitg. **51** 298[15] 306[16] (1890) : Tijdsh. Entom. **34** 54 (1891)[17] ; Dalla Torre Cat. Hym. **7** 116 (1893)[18] ; D. Sharp Trans. Ent. Soc. Lond. **1893** 206[19] ; Farren-White Ants' Ways 240 (1895)[20]. *Myrmica rubra* race *scabrinodis* Saunders Hym.-Acul. 40 (1896)[21]. *Myrmica scabrinodis* Donisthorpe Ent. Rec. **14** 16 (1902)[22]. *Myrmica rubra* Chitty Ent. Rec. **16** 206 (1904)[23]. *Myrmica rubra scabrinodis* Wheeler Bull. Amer. Mus. NH. 21 406 (1905)[24]. *Myrmica scabrinodis* Escherich Ameise 217 (1906)[25]. Wasmann Tijdschr. Ent. **48** 218–219 (1906)[56]. *Myrmica scabrinodis scabrinodis* Emery Deutsch.

Ent. Zeitschr. **1908** 176[27]. *Myrmica scabrinodis* Ellis and Martineau Ent. Rec. **20** 56 (1908)[28]; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 228 (1908)[29]: Ent. Rec. **21** 258 (1909)[30]. *Myrmica rubra* subsp. *scabrinodis* Wheeler Ants 566 (1910)[31]. *Myrmica scabrinodis* Crawley Ent. Rec. **22** 155 (1910)[52]; Donisthorpe Entom. **44** 390 (1911)[33]: Ent. Rec. **25** 3–4[34] 43–44[35] (1913); Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 18–19 (1913)[36]. *Myrmica scabrinodis* subsp. *scabrinodis* Emery Bull. Soc. Ent. Italiana **47** 120 (1916)[37]. *Myrmica scabrinodis* Johnson Irish Nat. **25** 62 (1916)[38]; Donisthorpe Ent. Rec. **28** 36 (1916)[39]: **30** 21 (1918)[40]: **31** 2 (1919)[41]. *Myrmica* (*Myrmica*) *scabrinodis* subsp. *scabrinodis* Emery Gen. Ins. **174** 40 (1921)[42]; Finzi Boll. Soc. Adriat. Sci. Nat. **29** 99 (1926)[43].

☿ *Light reddish yellow, sometimes dark red, with the head and gaster dark brown above, legs and antennae lighter; sculpture sharp and coarse. Head* somewhat the same shape as in *sulcinodis,* with even longitudinal ridges above; *frontal area* smooth and shining, except at the apex of the triangle, where some of the striae of the front of the head continue on to it; *antennae: scape* bent at a right angle at the base, and furnished with a more or less developed lateral tooth at the bend; *club* three-jointed. *Thorax: epinotal spines* long and strong, the space between smooth and shining, sometimes transversely striate. *Petiole* rugose, concave anteriorly, forming a distinct angle in profile; *post-petiole* longitudinally wrinkled. *Long.* 3·5–5 mm.

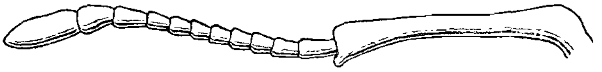


Fig. 68. Antenna of *Myrmica scabrinodis* ☿.

♀ *Lighter or darker reddish yellow, with dark patches on the thorax, sometimes nearly the whole of the upper surface is dark brown, with lighter mandibles, antennae and legs.*

Sculpture stronger, other characters as in the ☿. *Wings* fuscous at the base. *Long.* 5·8–6·5 mm.

♂ *Blackish brown, shining, club of antennae, tarsi and apex of gaster yellowish. Head* finely longitudinally striate; *antennae: scape* short, only as long

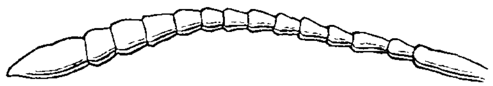


Fig. 69. Antenna of *Myrmica scabrinodis* ♂.

as the three first joints of the *funiculus* together; *club* more or less **four**-jointed. *Wings* as in the ♀. *Femora* thickened in the middle. *Long.* 4·8–6 mm. (5·5–6 mm. *teste Forel.*)

Original description of *Myrmica scabrinodis* Nylander [Acta. Soc. Sc. Fenn. **2** 930 (1846)]:—

" *Operaria:* testaceo-ferruginea sparse flavo-pilosula, capite supra et abdominis dorso medio fuscescentibus; capite, thorace et. petiolo longitudinaliter striatim profunde rugosis; antennarum scapo ad basin flexo, supra geniculo a lobo oblique-transversim posito; metanoti spinis longis.

☿ Long. 1¾–2 lin. Simillima iterum praecedenti, sculptura rudiori, area frontali obsoleta et antennarum scapo ut in diagnosi formato. Striae capitis,

thoracis petiolique rudes, profundiores quam in praecedentibus, pilositas corporis forte densior et praeterea lamina frontalis aliter constructa, infra nempe margine utrinque aurito-dilatato tenui, processum lamelliformem subsemirotundatum parum elevatum, radices antennarum obtegentem, formante. Area frontalis triangularis parva fere obsoleta. Scapus antennarum basi flexa supra lobo oblique-transverso parvo, subsemirotundato, antice concaviusculo, apice compresso, a parte anteriori viso geniculum parum acutiusculum ostendente. Spinae metanoti longae. Cetera proxime ut in praecedente.

Femina : testaceo-ferruginea sparse flavido-pilosula, capite supra et abdominis dorso medio fuscescentibus, thorace quoque supra et mesopleuris cum sterno parum fuscescentibus ; capite, thorace et petiolo longitudinaliter striatim profunde rugosis ; antennarum scapo ad basin geniculatim flexo, geniculo supra angulato ; spinis metanoti longiusculis ; alis hyalinis obsoletissime cinereo-pallescentibus, stigmate ejusdem coloris distincto.

♀ Long. 2½ lin. sat similis operariae suae, sed major obscurior. Caput fuscum, infra cum genis, mandibulis et antennis ferrugineo-testaceum. Areae triangularis frontis vix vestigium. Scapus flexurâ basis supra angulo subrecto, subtus arcuatâ (lobo distincto nullo). Spinae metanoti ut in specie praecedente sed nodi petiolares rudius sulcatim rugosi. Alae hyalinae albescentes, anticae 2½ lin. longae, a stigmate versus basin obsoletissime cinereo-pallescentes. Cetera ut in diagnosi vel in praecedente.

Mas : nigro-fuscus nitidus sparse tenuiter flavido-pilosulus, mandibularum apicibus et tarsis testaceo-pallescentibus, antennis fusco-rufescentibus ; scapo longitudine quintae partis totius antennae ; pedibus longe pilosis.

♂ Long. 2½ lin. Similis mari *M. laevinodis,* antennis vero longitudine tantum flagelli in eadem specie, scapo quintam solum efficiente partem totius antennae, pedibus longe flavido-pilosis. Mandibulae apice sordide pallidae. Antennae obscure rufescentes, longius tenuiusque pilosae quam feminae et operariae ; scapus subcylindricus, longitudine tantum trium articulorum insequentium, crassitudinem articuli ultimi superans ; pedicellus suborbiculatus crassior quam ullus septem articulorum sequentium, qui sunt longe verticillatim pilosi ; 9, 10 et 11 suborbiculati crassiores ; ultimus subconicus longitudine fere 10 et 11 (simul sumtorum), sed ejusdem ad basin crassitudinis. Est igitur flagellum ut in feminis fere hujus Generis formatum, at articulis 12. Alae minus albescentes quam in ♀. Pedes longe undique pilosi, pilis his cinerascentibus in tarsis fere longioribus. Anus obsolete pallescens."

Habitat.

Myrmica scabrinodis is found in North and Central Europe, Siberia, and Turkestan, and varieties[31] occur in the North and North-eastern States of America, in Alaska and British Columbia.

It is widely distributed in the British Isles, having been recorded as far north as South Aberdeen and Westerness in Scotland, whence I have records from Dumfries, Ayr, Renfrew, Haddington, Edinburgh, Linlithgow, Fife, Kinross, Stirling, South and Mid Perth, Main Argyle, Dumbarton, and the Mid Ebudes ; and in Ireland from Antrim, Down, Armagh, Monaghan, Tyrone, Donegal, Dublin, Wicklow, Wexford, Carlow, Kilkenny, Queen's Co., King's Co., Westmeath, West Mayo, East Galway, Clare, Waterford, North and South Cork, and Kerry. I have no records in England from South Wilts, Bedford, Hunts, East Gloucester, South-west and North-west Yorks ; and in Wales from Brecon, Cardigan, Montgomery, and Flint.

Myrmica scabrinodis nests under stones, on heaths and banks ; it does not readily dwell near houses, and on the whole prefers dry, sandy places. Indeed, Forel[9] states it does not occur in woods nor damp places, and never nests in tree trunks, but is to be found on the plains at the edges of woods and roads in dry places, exposed to the south, André[12] says it is uniformly established in dry places, Wasmann[17] gives dry, sandy soil on the borders of pine woods, etc., and Escherich[25] dry places.

On the other hand, Bouskell sent me several colonies from Kerry which he had found in the bogs, being all but covered with water[34], and I found a colony under a stone in a marsh at Studland, and several others in clumps of very damp sphagnum in the bogs in the New Forest.

It is stated not to extend to as high an altitude as *lobicornis*[12], nor to reach the region of the pines[9]. Hull has sent me *scabrinodis* from West Allendale taken at a height of 1000 ft., and though this species may prefer the plains and dry places, it appears to be generally distributed in Britain.

The colonies of this ant are not so populous as those of *laevinodis,* nor is it as warlike as that species, or *ruginodis.* Its sting is much more feeble, and though combats take place between colonies of the same species, the mortality is not nearly so great as in the battles of the two above ants.

This *Myrmica* is a skilful thief, robbing other ants of their prey, even entering their nests for this purpose, and also haunting the battle-fields of larger ants and devouring the dead.

Forel[10] records that he has seen single individuals enter the nests of *Acanthomyops flavus,* drag out a worker of that species, kill it, and carry it off as a prey. He goes on to say :—" I have seen a *scabrinodis* worker pull away the dead body of an insect from a *rufibarbis* worker on the dome of the latter's nest, and in spite of all the efforts of the *rufibarbis* to retain it. She feigned death, then quickly carried off the prey when the *rufibarbis* let go, allowed herself to be bitten, but never lost an instant to gain the ground. I saw another catch a cocoon which some *rufibarbis,* flying before *F. sanguinea,* were carrying. In vain more than twelve *rufibarbis* workers tried to pull it away, to make her let go, to cut off her head ; she remained motionless, clinging to the cocoon with her mandibles. Her patience surpassed that of the *rufibarbis,* and she ended by carrying off the cocoon so boldly stolen."

Crawley noticed at Oddington, Oxon, where a number of both *M. scabrinodis* and *A. flavus* colonies occurred on a lawn, that, at the entrances to the former's nests, an accumulation of a yellow refuse appeared, which kept on increasing. On examination it proved to be composed of vast quantities of the heads of the *flavus*[34].

The stealing habits of *scabrinodis* account for the fact that it is frequently met with near nests of *flavus,* and in the nests of other

ants. Gould wrote as long ago as 1747—" Very often the Red Ants reside in a distinct part of the Yellow Ant-Hills "—F. Smith[5] says *scabrinodis* is frequently met with, occupying one side of the same hillock in which *flavus* has formed its habitation—Farren-White[22] records that he has found *scabrinodis* occupying one side of the raised mound of *flavus,* and also sharing with this species the shelter of the same stone—Fryer sent me specimens of the *Myrmica* from a colony situated on the top of a large *A. flavus* mound 1 ft. 4 in. high at Woodington Wood[25]. I have observed the two species together on the following occasions—in the Isle of Wight[22], at Blackgang, July, 1894—three colonies of *scabrinodis* under the same stones as *flavus* at Bletchington on April 9th, 1913 —again at Tenby on April 25th, 1913—also on Lundy on June 9th, 1913, here the two species were quite mixed, but when the stone was moved they immediately attacked each other. Ellis and Martineau record *scabrinodis* in nests of *F. sanguinea* at Bewdley[28], and I have frequently found it with the same ant at Weybridge and Woking.

As we have seen under *M. ruginodis,* the seeds of the blue cornflower are collected by that species ; and I found that *M. scabrinodis* also exhibits a liking for them. Having accidentally scattered a number of these seeds near an observation-nest of this ant, the workers collected them and took them into the nest. They devoured the elaiosomes and buried the rest of the seeds in the earth of their nest[39].

Crawley has found *Myrmica scabrinodis* (as also *M. ruginodis* and *M. laevinodis*) invariably hostile to strange females[32], even when fertile and in cases where the colonies possessed no queens of their own, and strange workers were always killed. On the other hand, I have known strange colonies of *M. scabrinodis* to amalgamate. Two colonies sent to me by Bouskell in October, 1911, from Miltown, Co. Kerry, were arranged in a four-chambered Janet nest, so that each colony occupied two chambers at opposite ends, the passage connecting them being plugged with cotton-wool. One colony contained five females and workers, the other two females, workers and brood. On January 12th, 1912, the cotton-wool barrier was removed and the two nests allowed access to each other. No fighting was observed, but on March 2nd some females were dead. Later the remaining females and all the workers occupied the two dampest chambers in common, and the two colonies lived together on perfectly good terms, and in fact became one[36].

M. scabrinodis (and also *ruginodis* and *laevinodis*) will readily accept pupae of their own species from strange nests, and bring them to maturity, but *scabrinodis,* at any rate, will not rear pupae of the other species.

Angus[14] records specimens of *scabrinodis* found in the stomach of a green Woodpecker (*Picus viridis*) shot in January in North

Wales, Wasmann found the remains of thousands of workers in the droppings of this bird in Holland[26], and Chitty[23] mentions the Tiger-beetle (*Cicindela campestris*) feeding on *Myrmica rubra* (from what he told me the species was probably *scabrinodis*).

Dr. Sharp[19] describes the mechanism with which this species stridulates as follows :—

"*Myrmica scabrinodis* (worker). England. The base or neck, of the segment behind the second node is quite short, and is at the sides covered with sharply raised, quite irregular, rather short, transverse lines ; in the middle there is a broad space appearing perfectly smooth and polished, but which, under a high power, proves to be very regularly covered with straight, very fine ridges. The perfect regularity of these fine lines is highly remarkable. The edge, on the hind margin of the second node, by which these lines are scraped is excessively thin."

The males and winged females may be found in the nests from June to September, and the marriage-flight takes place chiefly in August and September. Nylander[3] records a marriage-flight of this species at Borgoam, in Emsalö, on August 22nd, 1846 ; Forel on the summit of Mont-Tendre on August 30th, 1871 ; Farren-White[20] captured a male flying over the cairn which crowns the head of Snowdon in August, 1879 ; Crawley and I noticed males and females leaving their nest and swarming up the grass stems on the cliffs at Sandown, Isle of Wight, on August 12th, 1913, and on August 14th I observed clouds of these ants flying at Shanklin. Scott sent me males and females from a marriage-flight, taken at a height of 1000 ft. at Llandrindod Wells on September 5th, 1912, and Harwood winged females taken flying at Clacton-on-Sea on October 12th, 1912. Johnson observed males flying along the sea-shore at Coolmore, Co. Waterford, in mid-September, 1915[38]. I have observed that in observation-nests the males will endeavour to embrace the workers[39]. In one nest I kept, the colony of which was dug up from a sandy bank on Barnes Common on July 2nd, 1915, the queen was a very small, very dark (nearly black) ant, the workers being large and typical.

Wasmann often found in colonies of *M. scabrinodis* at Exaeten, in Holland, single individual workers, nearly double the usual size, with heads the shape of that of a female, though relatively the size of that of a worker, the rest of the body being of the usual form, and no intermediate forms were present[16].

The same observer records the capture of an ergatandromorph in a colony of this ant, also at Exaeten, in September, 1886, in which a number of males and winged females were present[15].

It is an approximately lateral ergatandromorph with left half of the body almost entirely that of a worker, whereas the right half is that of a normal male. Left (worker) half of head larger than the right, opaque, coarsely and longitudinally rugose, with a large yellowish red blotch above, sharply delimited on the right side as far as the middle of the face, extending back on the

left to the middle of the side of the head as far as the first third of the superior orbit, and anteriorly to the antennal insertion, which is encircled by a black ring. Mandibles, antennae and left half of clypeus yellowish red, the remainder of the head black. Right half of head smaller, more finely longitudinally furrowed and therefore more shining (male). Right eye larger (male), left smaller (worker). Ocellus lacking in that portion of the vertex corresponding to the left side of the head (worker). The two remaining ocelli are present, the median lying rather accurately on the boundary of the black side of the head, but still entirely on that side. Right mandible male in size, shape and number of teeth, but reddish yellow (worker), whereas normally the male mandibles are reddish yellow only at their tips. Left, much more robust, mandible entirely worker. Antennae both alike, thirteen-jointed, almost purely male, but very short and sparsely hairy in contradistinction to the long, abundant pilosity of the normal male antennae in *Myrmica scabrinodis*. They are also lighter in colour, being almost uniformly reddish yellow as in the worker.

Dollman picked up a dead ergatandromorph on a path on the downs at Ditchling[30] in September, 1909, which he kindly presented to me, and which I have described as follows[35] :—

"Approximately lateral ergatandromorph, right half of body almost entirely that of a ☿, the left being that of a normal ♂ (the left half being blackish and the right reddish yellow). Right half of head rugosely striate, larger than left, eye smaller; right antennae yellow, club three-jointed; scape with strong lateral tooth at the bend; right half of thorax yellow; epinotum with a strong spine; right half of petiole and post-petiole yellow, rugose and punctured; right half of gaster light fuscous-yellow; legs on right side yellow, typical ☿. Left side of head blackish, punctured, not rugosely striate; eye larger; median and left ocelli present; antenna fuscous with four-jointed club; left half of thorax blackish; epinotum not armed with a spine; petiole and post-petiole fuscous-black, smooth; the greater part of the left half of the gaster has been eaten away, but what remains is of a darker fuscous colour than the right. Legs on left side fuscous, typical ♂; wings typical ♂."

In this specimen the scape of the left antenna (male) is longer than in typical *scabrinodis* male, and the tooth on the right antenna (worker) is large, it therefore comes near to the var. *sabuleti* Meinert.

Wheeler[24] records the capture of three pterergates in a small colony of a form of *Myrmica scabrinodis* at Bronxville, New York, on September 5th, 1904. This colony comprised about 150 workers and a deälated female of rather small size. Three of these workers bear vestiges of anterior wings, but are in every other respect perfectly normal individuals. In the structure of the thorax, there is not the slightest approach to the female type. Each of the three specimens represents a different condition in the development of the wings. In one the wing vestiges are nearly 1·7 mm. long, spatulate in outline and very slender at their bases, where they are furnished with small but distinct tegulae. The appendages are yellowish brown, translucent and covered with minute hairs like those on the normal wings of females, but without any traces

of venation. In another worker the wings are barely ·4 mm. in length and are merely little opaque pads or sacs, without even a trace of hairs on their surfaces, although they have minute tegulae at their bases. In the third specimen the wings are even more vestigial, the right being represented by a small nodular appendage and its tegula, the left by a minute papilla. Keys found in a colony of *scabrinodis* at Yelverton, in August, 1913, in which a typical deälated female and males were present, a worker which is a little larger than the other workers from the same nest, measuring 5 mm. in length (the latter being from 4·5 to 4·8 mm. long), the head is rounder and more the shape of a female, and the thorax a little higher, but otherwise that of a normal worker. Two minute chitinous nodules are present on each side of the mesothorax anteriorly.

In July, 1913, I found a form of *scabrinodis* at Rannoch, in two nests of *Formica rufa* v. *alpina*, inhabiting part of the latter's hillocks, but only workers and larvae were found. The scape of the antennae exhibits a slight transverse ridge (more developed in some specimens) reaching across from the lateral tooth, and forming a small point, or angle, opposite to the same. These specimens probably come near the variety *scabrinodo-lobicornis* Forel, their colour, however, being that of normal *scabrinodis*. In many points these specimens come nearer to *ruginodis*, the scape of the antennae being curved, though slightly bent, at the base. The space between the epinotal spines is transversely striate. In 1922, Phillips took workers from a colony of *scabrinodis* at Ennis, Co. Clare, which also approach *ruginodis* in some particulars.

Chapman recorded the prolonged life in a headless ant of this species which far exceeds that before mentioned under *M. ruginodis*. On this occasion the ant in question lived without its head for fifty-nine days ! [Ent. Rec. **30** 42 (1918)].

I have taken the Aphids—*Forda formicaria* Heyden, *F. viridana* Buckton, *Schizoneura corni* F., *Trama troglodytes* Heyden, *T. radicis* Kalt., *Brysocrypta lactucaria* Pass., *B. ranunculi* Kalt., and *Tetraneura ulmi* Geoff., in *scabrinodis* nests.

The undermentioned myrmecophiles have occurred with this species in Britain[35] :—

Coleoptera : *Atemeles emarginatus* Pk., *Myrmedonia limbata* Pk., *Drusilla canaliculata* F., *Atheta analis* Gr., *Staphylinus stercorarius* Ol., *Othius myrmecophilus* Kies., and *Batrisodes venustus* Reich.

Formicidae : *Myrmecina graminicola* Latr.
Ichneumonidae : *Pezomachus aquisgranensis* Först.
Braconidae : *Pachylomma buccata* Nees.
Proctotrupidae : *Exallonyx fumipennis* var. *donisthorpei* Kief.
Lepidoptera : *Lycaena arion* L., larva.
Heteroptera : *Nabis lativentris* Boh.

Coccidae : *Ortheziola vejdovskyi* Sulc.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic.

Araneina : *Myrmarachne formicarius* De. G., *Synageles oenator* Lucas, and *Phrurolithus minimus* C. K.

Acarina : *Laelaps* (*Hypoaspis*) *myrmophilus* Mich., *L.* (*H.*) *acutus* Mich., and *L.* (*Cosmolaelaps*) *vacuus* Mich.

Crustacea : *Platyarthrus hoffmanseggi* Brandt.

Myrmica scabrinodis Nyl. var. sabuleti Meinert.

Myrmica sabuleti Meinert Kong. Danske. Vidensk. Selsk. Skrift. **5** 327 (1861)[1]. *Myrmica lobicornis* Nyl. var. *sabuleti* Er. André Hym. Europe **2** 318 (1881)[2]. *Myrmica scabrinodis scabrinodis* Nyl. var. *sabuleti* Emery Deutsch. Ent. Zeitschr. **1908** 176[3]. *Myrmica scabrinodis sabuleti* Bondroit Ann. Soc. Ent. Belg. **53** 495 (1909)[4]. *Myrmica rubra* subsp. *scabrinodis* Nyl. var. *sabuleti* Wheeler Ants 566 (1910)[5]. *Myrmica sabuleti* Donisthorpe Ent. Rec. **24** 306 (1912)[6]. *Myrmica scabrinodis* Nyl. var. *sabuleti* Donisthorpe Ent. Rec. **25** 45–46[7] 62[8] 267[9] (1913). *Myrmica scabrinodis scabrinodis* var. *sabuleti* Emery Bull. Soc Ent. Italiana **47** 120 (1916)[10]. *Myrmica scabrinodis* var. *sabuleti* Donisthorpe Ent. Rec. **29** 31 (1917)[11]: 31 1 (1919)[12]. *Myrmica* (*Myrmica*) *scabrinodis* subsp. *scabrinodis* var. *sabuleti* Emery Gen. Ins. **174** 40 (1921)[13]. *Myrmica scabrinodis* var. *sabuleti* Donisthorpe Ent. Rec. **36** 50 (1924)[14]; Finzi Boll. Soc. Adriat. Sci. Nat. **29** 101 (1926)[15].

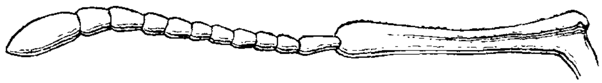


Fig. 70. Antenna of *Myrmica scabrinodis* v. *sabuleti* ☿.

In this variety the worker and female possess a much more developed lateral tooth to the scape of the antennae than in *scabrinodis* proper, and the longitudinal keel on its upper side is very distinct. The male is to be known by the longer scape, which is as long as the first five joints of the funiculus taken together.

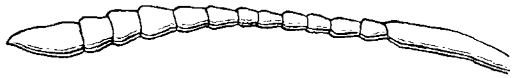


Fig. 71. Antenna of *Myrmica scabrinodis* v. *sabuleti* ♂.

In my experience whenever these males with long scapes are found, the females and workers in that colony always exhibit the large development of the lateral tooth, etc., and *sabuleti* no doubt represents the extreme form of development of *scabrinodis* in this direction.

Original description of *Myrmica sabuleti* Meinert [Kong, Danske. Vidensk. Selsk. Shrift. **5** 327 (1861)] :—

" Dronning : Ubekjendt.

Arbeider : Rødguul ; Bagkroppens Overside mørkere. Antennernes Skaft bøiet i en naesten ret Vinkel, Roden med en Tand og paa Oversiden med en

høi, skarp Laengdekjøl. Pandefligene store, øreformige. Pandeegnen heelt eller tildeels rynket. Hovedets Sider med unregelmaessig Sculptur, Midten, Thorax og Stilkens Knuder, de sidste staerkt, laengderynkede. L. 2¼‴.

Han : Sort ; Antennerne for største Delen, Bagkroppens Spidse, Benenes Laddemode og Fødderne gule. Antennernes Skaft en tredie Deel af Svøbens Laengde, det sidste Led laengere end de to foregaaende tilsammen, ofte bøiet eller deelt i Midten. Antennerne naesten nøgne ; Benene med lange skraat stillede, tildeels naesten lodrette Børster. Stilkens første Knude staerkt laengderynket. Vingrene graabrune til over Midten. L. 2½–2¾‴."

The following is a translation of Meinert's Danish description :—

♀ Unknown.

☿ : Reddish yellow ; gaster darker above. Antennal scape bent almost at right angles, base with a tooth, and on the upper side with a high, sharp longitudinal keel. Frontal flaps large, ear-shaped. Frontal portion wholly or partly wrinkled. Sides of head irregularly, thorax and nodes of pedicel distinctly wrinkled longitudinally. *Long.* 2¼ lin.

♂ : Black ; antennae for the greater part, apex of gaster, joints of legs and feet yellow. Antennal scape a third of the length of the funiculus, the last joint longer than the two preceding ones together, often bent or divided in the middle. Antennae almost bare ; legs with long, oblique, sub-erect hairs. First node of pedicel wrinkled longitudinally. Wings greyish brown to beyond middle. *Long.* 2½–2¾ lin.

Habitat.

According to Emery[3] this variety extends further south, in the Palaearctic Region, than the type, and Wheeler[5] records it from the northern states of North America.

In Britain it has occurred in :—

Cornwall, E. : Whitsand Bay (*Keys*).
Devon, S. : Plymouth district (*Keys*) ; Seaton (*Donisthorpe*)[7] ;
Devon, N. : Lundy Island (*Donisthorpe*)[9].
Somerset, N. : Flax Bourton and Durdham Downs (*Bacchus*).
Wilts, N. : Savernake Forest (*Butler*).
Dorset : Bloxworth (*O. P. Cambridge*).
Isle of Wight : The Landslip near Shanklin (*Donisthorpe*).
Hants, S. : New Forest (*Donisthorpe*)[7].
Kent, E. : Dover (*Donisthorpe*)[14].
Surrey : Box Hill (*Donisthorpe*)[7].
Herts : Hitchin (*Durrant*).
Berkshire : Boar's Hill (*Hamm*).
Oxford : Shotover (*Hamm*)[8] ; Wolvercote (*Collins*).
Suffolk, W. : Cavenham (*Harwood*).
Bedford : Sharpenhoe (*Hodson*).
Northampton : Loddington (*S. O. Taylor*).
Gloucester, W. : Bristol (*Bacchus*).
Monmouth : Trelleck (*Hallett*).
Worcester : Bewdley (*Donisthorpe*)[11].
Salop : Church Stretton (*G. C. Leman*)[12].

Glamorgan : Cwrt-yr-ala (*Hallett*).
Pembroke : Tenby (*Donisthorpe*) ; St. David's (*Allen*).
Cheshire : Delamere (*Arnold*).
Yorks, Mid.-W. : Grassington (*Butterfield*).
Westmorland : Grange-over-Sands (*Britten*).
Isle of Man : (*Blair*).
Easterness : Loch-an-Eilean (*Rothney*).
Dublin : Howth Head (*Stelfox*).
Wicklow : Devil's Glen (*Stelfox*).
Wexford : Rosslare (*Phillips*).

The habits of *sabuleti* are similar to those of *scabrinodis*. I found a colony occupying the same mound as *Acanthomyops flavus* in the Isle of Wight in August, 1913, and another similarly situated at Bewdley on June 17th, 1916[11]. I have taken the males and winged females in the nests in July, August, and September.

I found a dead female of this variety in a nest of *A.* (*D.*) *niger* at Dover on May 1st, 1923[14]. Hodson found workers fighting with *M. laevinodis* at Sharpenhoe, Beds, in April, 1923[14].

A large colony found at the foot of a post in the New Forest on July 18th, 1918, contained very many winged females, but only male pupae. Some of the winged females were observed to carry the pupae into safety. On July 18th this colony was visited again, when numerous males had hatched. One of these is peculiar in that there are apparently no nerves visible in the wings[12].

The following myrmecophiles have been captured with *M. sabuleti* in Britain :—

Coleoptera : *Atemeles emarginatus* Pk., and *Lamprinus saginatus* Gr.

Lepidoptera : Dr. Chapman has taken the larva of the " Blue Butterfly " (*Lycaena arion* L.) in the nest of this variety in North Devon, and has demonstrated that it devours the ants' larvae.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic.
Araneina : *Harpactes hombergi* Scp.
Acarina : *Uroplitella donisthorpei* Hull.
Crustacea : *Platyarthrus hoffmanseggi* Brdt.

Myrmica lobicornis Nyl.

Myrmica lobicornis Nylander Acta. Soc. Sc. Fenn. **2** 932[1] 1052[2] (1846) : **3** 31 (1849)[3] ; Schenck Jahr. Ver. Naturk. Nassau **8** 82 (1852)[4]. *Myrmica denticornis* Curtis Trans. Linn. Soc. Lond. **21** 215 (1854)[5] ; F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 120 (1855)[6]. *Myrmica lobicornis* F. Smith Cat. Brit. Foss. Hym. 25 (1858)[7] : Trans. Ent. Soc. Lond. (n.s.) **4** 279 (1858)[8] : Ent. Ann. **1860** 92[9] ; Meinert Kong. Danske. Vidensk. Selsk. Skrift. **5** 327 (1861)[10] ; F. Smith Ent. Mo. Mag. **2** 29 (1865)[11] ; Ent. Ann. **1866** 128[12] ; Bold Ent. Mo. Mag. **2** 234 (1866)[13] ; F. Smith Entom. **3** 197 (1866)[14] : Ent. Ann. **1868** 94[15]. *Myrmica rubra* race *lobicornis* Forel Denkschr. Schweiz. Ges. Naturw. **26** 77–79[16] 226[17] 403[18] (1874). *Myrmica lobicornis* B. Cooke Nat. **5** 73 (1879)[19] ; Saunders Trans. Ent. Soc. Lond. **1880** 216[20] ; Er. André Spec. Hym. Europe

2 318 (1881)[21]. *Myrmica nodicornis* Chappell Young Nat. **7** 58 (1886)[22]. *Myrmica lobicornis* Bridgman Trans. Norf. Norwich Nat. Soc. **4** 394 (1886)[23] : 690 (1889)[24]; Dalla Torre Cat. Hym. **7** 111 (1893)[25]; Farren-White Ants' Ways 241 (1895)[26]. *Myrmica rubra* race *lobicornis* Freke Irish Nat. **5** 40 (1896)[27]; Saunders Hym.-Acul. 40 (1896)[28]; Morley Hym. Suffolk **1** 2 (1899)[29]; Vic. Hist. Cumberland **1** 103 (1901)[30]; Vic. Hist. Essex **1** 102 (1903)[31]; Vic. Hist. Devon **1** 188 (1906)[32]. *Myrmica lobicornis* Escherich 217 (1906)[33]; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 228 (1908)[34]. *Myrmica scabrinodis lobicornis* Emery Deutsch. Ent. Zeitschr. 1908 179[35]. *Myrmica lobicornis* Nyl. var. *arduennae* Bondroit Ann. Soc. Ent. Belg. **55** 12 (1911)[36]. *Myrmica lobicornis* Donisthorpe Ent. Rec. **23** 11 (1911)[37] : Entom. **44** 390 (1911)[38] : Ent. Rec. **24** 5 (1912)[39]; Evans Scot. Nat. **1912** 108[40]; Hallett Trans. Cardiff Nat. Soc. **45** 2 (1913)[41]; Donisthorpe Ent. Rec. **25** 46–47 (1913)[42]; Emery Bull. Soc. Ent. Italiana **47** 120 (1916)[43]. *Myrmica* (*Myrmica*) *lobicornis* Emery Gen. Ins. **174** 37 (1921)[44]. *Myrmica lobicornis* Finzi Boll. Soc. Adriat. Sci. Nat. **29** 106 (1926)[45].

☿ *Lighter or darker brown-red, head and gaster, and sometimes the whole body blackish brown ; antennae and legs lighter.*

Head : frontal area more or less longitudinally striate, sometimes shining and only shagreened ; *antennae* with *scape* sharply bent at the base, and

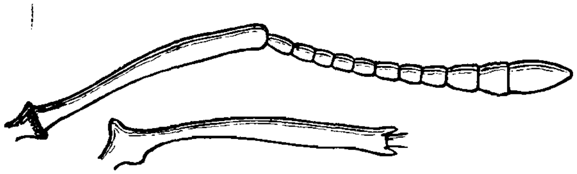


Fig. 72. 1. Antenna of *Myrmica lobicornis* ☿.
2. The same in profile.

furnished above at the bend with a strong transverse ridge, which, when seen in profile, has the appearance of a spine ; *club* of antennae three-jointed. *Thorax : epinotal spines* variable in length, the space between sometimes smooth and shining, sometimes somewhat striate transversely. *Long.* 4–5 mm. (3·5–5 mm. *teste Forel.*)

The striation and reticulation of the head, and the rugosity of the thorax and pedicel is variable, often in individuals from the same colony ; the *denticornis* Curtis, and the var. *arduennae* Bondroit appear to be founded on such varieties.

♀ *Head and gaster blackish brown, thorax and pedicel red, with some black patches on the former ; often the whole body is blackish brown ; antennae and legs lighter.*

Other characters as in the ☿. *Long.* 5–5·5 mm. (5–6½ mm. *teste Forel.*)

♂ *Blackish brown, shining ; mandibles, club and base of scape of antennae, tarsi, femora and tibiae at base and apex, and extremity of gaster yellowish.*

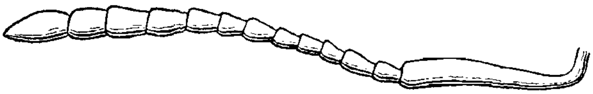


Fig. 73. Antenna of *Myrmica lobicornis* ♂.

Head finely striate, with distinct frontal channel ; *frontal area* finely striate longitudinally, or simply shagreened ; *antennae* with *scape* abruptly bent at the base, about half the length of the funiculus ; *funiculus* short, with a four-jointed club. *Thorax* striate ; space between *epinotal tubercles* smooth and shining. *Petiole* finely striate ; *post-petiole* smooth and shining. *Long.* 5–5·5 mm. (5–6 mm. *teste Forel.*)

Original description of *Myrmica lobicornis* Nylander. ☿♀ [Acta. Soc. Sc. Fenn. **2** 932–934 (1846)] :—

" *Operaria :* obscure rubida sparse flavido-pilosula, capite et abdomine fusco-nigrescentibus, mandibulis antennisque rufescentibus ; capite, thorace et petiolo longitudinaliter striatim profunde rugosis ; antennarum scapo ad basin curvato, supra lobo transversim posito ; metanoti spinis longis.

☿ Long. 1⅔–2 lin. Similis praecedenti, at minus forte robusta, colore jam et scapi formatione alia distincta. Mandibulae pallide ferrugineae apice summo fuscescente. Area frontalis conspicua. Lamina frontalis ut in praecedente, marginibus infra utrinque dilatatis parum reflexis. Antennae obscurius, quam mandibulae, rufae ; scapus lobo compresso antice parum concaviusculo, formae laminae subsemirotundatae, transversim supra flexuram prope basin posito. (Est hic lobus paullo major, compressior, neque oblique positus, sicut in praecedente.) Caput lateribus reticulatim rugosum. Thorax et petiolus longitudinaliter crasse scabri, sordide fuscescenti-rubidi ; nodi sculptura rugosa crassa inaequali longitudinali. Pedes sordide ferrugineo-pallescentes. Abdomen apice obsolete pallescens.

Femina : fusca sparse flavido-pilosula ; mandibulis apice, antennis et pedibus pallide rufescentibus ; capite, thorace et petiolo longitudinaliter striatim profunde rugosis ; antennarum scapo ad basin curvato, supra lobo transversim posito ; metanoti spinis longiusculis ; alis hyalinis nervis et stigmate dilute cinereo-pallescentibus.

♀ Long. 2½ lin. Similis quoque feminae praecedentis, sed colore et scapo aliter formato mox distincta. Mandibulae apicibus late pallide-rufescentibus. Area triangularis, lamina frontalis et scapus antennarum ut in ☿. Thorax fuscus, pronoto antice inaequaliter crasse rugoso, ceteroquin longitudinaliter crasse striatus, infra et apice obsolete rubido-rufescens. Nodi fusci infra rubido-rufescentes, crasse sublongitudinaliter rugosi. Alae ut in praecedente, sed fere adhuc obsoletius colore cinereo-pallescente dilutissimo tinctae ; anticae long. 2⅓ lin. Pedes nitidi ferrugineo-pallescentes longe flavo pubescentes. Abdomen apice obscure fusco-rufescente."

The ♂ of *Myrmica lobicornis* was described by Nylander [Acta. Soc. Sc. Fenn. **3** 31 (1849)] as follows :—

" *Mas :* nigro-fuscus nitidus parce tenuiter flavido-pilosulus, mandibulis, antennis et pedibus testaceo-pallescentibus, scapis, femoribus tibiisque obscuratis ; fronte, pleuris et nodo primo petioli longitudinaliter striatulis ; scapis basi curvatis longitudine tertiae partis totius antennae ; alis hyalinis obsoletissime cinereo-pallescentibus ; pedibus pubescentibus ; corpore fere 5 millimetra longo.

Characteribus illis ab affinibus cognitis statim discernendus, *M. laevinodi* ♂ paulo minor. Caput subtilissime in fronte longitudinaliter et alibi granulatim rugosum ; antennae 13-articulatae sparse breviter pilosulae, paululum longiores quam apud *M. scabrinodem* ♂ (multoque nudiores), scapus pallide fuscescens basi subangulatim (fere ut in *M. sulcinodi* ☿) curvatus, longitudine articulorum 5 sequentium ; articuli 3–6 aequales parvi, 7–8 sensim majores ; flagellum et apex scapi pallide testacea. Thorax meso-, metapleuris, scutello et metanoto longitudinaliter striatis ; metathorax postice processu obtuse-angulato vel subdentiformi utrinque, spatio excavato laevi nitido. Alae ut

in *M. scabrinodi*, fere pallidiores, anticae 4½ millim. longae. Pedes pubescentes olivaceo-pallidi, articulationibus tarsisque testaceo-pallidis. Nodus petioli anterior longitudinaliter parum striatulus posterior laevis. Abdomen saepe apice et marginibus segmentorum paulo pallescentibus."

Habitat.

Myrmica lobicornis occurs in North Europe; farther south a mountain species (Alps, Apennines); eastwards to Central Asia[35].

The British distribution is as follows:—

Devon : (*Vic. Hist. Devon*)[32]; **Devon, N.** : Brendon Common (*Farren-White*)[26].

Somerset, S. : Exmoor (*Farren-White*)[26]; **Somerset, N.** : Leigh (*Smallcombe*).

Hants, S. : New Forest (*Donisthorpe*)[34]; **Hants, N.** : Fleet (*Hodson*).

Sussex, E. : Seaford (*Rye*)[12].

Kent, E. : Dover (*F. Smith*)[11]; Whitstable (*Donisthorpe*)[39].

Surrey : Shirley (*Rothney*)[15]; Wimbledon Common[39], Weybridge[37], and Richmond Park[34] (*Donisthorpe*); Chobham[20] and Woking (*Saunders*)[28].

Essex : (*Vic. Hist. Essex*)[31]; **Essex, S.** : Chingford and Loughton (*E. A. Butler*).

Berkshire : Bagley Wood (*Hamm*); Newbury (*Hamm*).

Suffolk, E. : Pakefield[9] and Lowestoft[12] (*F. Smith*); Foxhall (*Morley*)[29].

Norfolk, E. : Mousehold (*Thouless*)[23].

Northampton : Wakerley Wood (*S. O. Taylor*).

Glamorgan : Pontneathvaughan (*Hallett*)[41].

Merioneth : Cader Idris (*Scott*).

Carnarvon : Aber Waterfall (*Farren-White*)[26]; Deganwy (*W. Gardner*).

Denbigh : Llangollen (*Chappell*)[22].

Leicestershire : Groby Pool, Owston and Buddon Wood (*S. O. Taylor*).

Cheshire : Bowdon (*B. Cooke*)[19]; West Kirby (*Hallett*).

Yorks, S.W. : Keighley (*Butterfield*); **Yorks, N.W.** : Widely distributed (*Butterfield*).

Durham : South Shields (*Bold*)[13].

Northumberland, S. : Whitley and Blyth (*Bold*)[13].

Cumberland : near Carlisle (*Vic. Hist. Cumberland*)[32]; Saddleback (*Britten*).

Haddington : North Berwick (*Evans*)[40].

Edinburgh : near Inveresk (*Evans*)[40].

Fife and Kinross : N. Queensferry (*Donisthorpe*)[34]; Kinghorn[40]; St. David's, and Isle of May (*Evans*).

Perth, S. : Callander (*Evans*)[40]; **Perth, Mid.** : Rannoch (*Dale*)[26].

Easterness : Nethy Bridge (*Donisthorpe*).

Ebudes, Mid. : Isle of Mull (*Donisthorpe*)[39].
Sutherland, E. : Golspie (*Yerbury*).
Armagh : Armagh (*Johnson*)[27].

This species was first discovered in Britain by Curtis, who captured males and workers in Scotland in 1825[5], and subsequently Dale found a female and workers at Rannoch[26]. F. Smith described Dale's female in 1855[6], but curiously enough when he recorded (in 1860) females taken by himself on the cliffs at Pakefield he stated that it was the first time the female had been found in this country[9].

M. lobicornis lives in small communities, nesting chiefly in sandy places, under stones, in banks, etc. It is the least warlike of our species, possessing a feeble sting, and its habits are somewhat similar to those of *M. scabrinodis.* It prefers to dwell in dry places, but I once found it, on September 14th, 1911, on the Isle of Mull in wet sphagnum in a bog[39]. According to Forel[17], André[21], and Escherich[33] this *Myrmica* is chiefly a mountain species, and the first of these myrmecologists records it on high pastures in the region of the fir trees, rarely occurring in the plains, or as a subalpine species, and states that the alpine forms are smaller and darker.

In Scotland I have found it near the Forth Bridge in the Lowlands, and on the shores of Loch Rannoch and at Nethy Bridge in the Highlands, but never actually on the mountains, and of course in the south of England it occurs on heaths and plains, such as in the New Forest and at Weybridge, etc. Bold when recording it for Northumberland and Durham, speaks of it as a littoral species, living on sand-banks[13].

M. lobicornis, like *M. scabrinodis*, is sometimes found in, and near, the nests of other ants—Rothney took a female and many workers in nests of *Formica sanguinea* at Shirley[15], Hallet records its capture near a nest of *F. rufa* in Glamorgan[41], and in a nest of *F. fusca* at West Kirby, and I found two colonies of this ant, at Weybridge on July 22nd, 1911, both situated beneath a nest of *F. sanguinea*[39].

According to Schenck the marriage-flights take place from the end of July to the end of September; he first captured a winged female on July 28th, and at the beginning of October he found males and winged females in some numbers in the herbage[4]. Forel witnessed a marriage-flight on the summit of Mont Tendre on July 30th, 1871[18], Nylander captured a winged female at Helsingfors in August, 1846[2], and I have found males and winged females in the nests in July, and August, and on July 21st and September 22nd, 1913, I observed isolated deälated females crawling about on paths at Weybridge. Scott captured a male and a winged female of *lobicornis* (and also males of *scabrinodis*) on the summit of Cader

Idris (2927 ft.), on August 17th, 1925. On August 13th, 1914, I found a large colony in a bank at Weybridge which contained a number of workers, three winged females, and between twenty-five and thirty queens.

Meinert described a mixed frontal gynandromorph, in which the head is female in size, the thorax and external genitalia, as well as the colour and sculpture of the body, being male. The wings are intermediate between those of the two sexes[10].

Bugnion captured a male and female of a small *Myrmica* in a nest of *M. lobicornis* at Anzeindaz, at a height of 2000 metres in the Swiss Alps, which were first recorded by Forel as a very curious small form of the latter. He remarks, however, that had they not been taken in company with the males, females and workers of *lobicornis*, he would have considered them to belong to another species[16]. He subsequently described them as a new species under the name *Myrmica myrmicoxena* [Verhandl. 66 Versamm. D. Naturf. Ärzte Wien 143 (1894)]. This ant is probably a workerless parasite, or perhaps a guest-species, living in the nests of *M. lobicornis*.

I have taken the Braconid *Pachylomma buccata* Nees, and the Dipteron *Pseudacteon formicarum* Verrall, hovering over workers of *lobicornis* at Weybridge[42], and the Collembola *Cyphodeirus albinos* Nic., in the nests.

Myrmica schencki Em.

Myrmica rubra subsp. *scabrinodis* var. *schencki* Emery Zool. Jahrb. Syst. **8** 315 (1895)[1]. *Myrmica scabrinodis schencki* Emery Deutsch. Ent. Zeitschr. **1908** 178[2]. *Myrmica rubra* subsp. *scabrinodis* var. *schencki* Wheeler Ants 566 (1910)[3]. *Myrmica schencki* Bondroit Ann. Soc. Ent. Belg. **55** 11 (1911)[4]: **56** 351 (1912)[5]. *Myrmica scabrinodis* subsp. *schencki* Karawajew Rev. Russe Ent. **12** 583 (1912)[6]. *Myrmica scabrinodis* race *schencki* Forel Mitt. Schweiz Ent. Gesell. **12** 29 (1915)[7]. *Myrmica schencki* Donisthorpe Ent. Rec. **27** 265 (1915)[8]. *Myrmica scabrinodis* subsp. *schencki* Emery Bull. Soc. Ent. Italiana **47** 120 (1916)[9]. *Myrmica schencki* Hallett Trans. Cardiff N.S. **48** 73 (1916)[10]: **49** 64 (1917)[11]; Donisthorpe Ent. Rec. **29** 31 (1917)[12]. *Myrmica (Myrmica) scabrinodis* subsp. *schencki* Emery Gen. Ins. **174** 41 (1921)[13]. *Myrmica schencki* Finzi Boll. Soc. Adriat. Sci. Nat. **29** 109 (1926)[14].

Fig. 74. Scape of antenna of *Myrmica schencki* Emery in Profile (F. J. Kirk).

☿ *Lighter or darker brownish red, head and gaster darker; mandibles, antennae and legs lighter. The colour is lighter and more uniform over the whole body than in* lobicornis.

Head: frontal area longitudinally striate, not shining; *temples* more regularly striate than in *lobicornis*; *antennae* with *scape* sharply bent at the base, and furnished above with a strong transverse ridge, which, however, is

both broader and longer than that of *lobicornis,* and is not so pointed in profile, the *scape* itself also being longer; *club* of antennae three-jointed. *Thorax* more regularly striate; *epinotal spines* long and straight, longer than in *lobicornis,* with the space between smooth and shining. *Petiole* and *post-petiole* not so strongly rugose as in *lobicornis,* the former seen in profile does not form such a strong or abrupt angle, and the latter seen from above is rounder. *Long.* 4·5 mm.–5 mm. (4 mm.–5 mm. *teste Emery.*)

♀ *Head and gaster blackish brown, scutum of mesonotum with a black patch anteriorly and two others, one on each side, posteriorly, prae-scutellum, post-scutellum, and metanotum black; mandibles, antennae, rest of body and legs reddish yellow. The whole colouring is lighter than in* lobicornis.

Other characters as in ☿. *Wings* with *pterostigma and veins* pale brown, not as yellow as in *lobicornis. Long.* 6 mm.

♂ *Deep blackish brown, shining; tarsi yellowish; club of antennae and articulations of joints of legs yellowish brown.*

Head: striate longitudinally, closely punctured between the striae, with a deep impression on front, just above *median ocellus*; *antennae* with *scape* slightly bent, short, not longer than the first three joints of funiculus taken together; *funiculus* slender with a more or less five-jointed *club. Thorax: mesonotum* smooth and shining between the *Mayrian furrows*; *scutum* towards base and *scutellum* longitudinally striate; *epinotum* rather widely longitudinally striate, with somewhat sharply pointed tubercles, space between smooth and shining. *Petiole* finely punctured; *post-petiole* smooth and shining. *Legs* slender. *Wings* as in ♀. *Long.* 5 mm.

From the male of *M. lobicornis* it may be at once recognized by the much shorter scape of the antennae; from *M. scabrinodis* and the var. *sabuleti,* it may be known by its more strongly and closely punctured, less shining head, considerably less stout antennae and legs, and shorter exserted hairs on the tibiae and other parts.

Described from a number of workers, three females and two males from Glamorgan. The workers agree closely with specimens I possess from Switzerland and Belgium.

Original description of *Myrmica schencki* Emery [Zool. Jahrb. Syst. **8** 315 (1895)]:—

"Diese Form wurde bis jetzt mit *M. lobicornis* Nyl. verwechselt und vermengt.—Der ☿ ist von derselben durch längere Dornen des Metanotums verschieden. Der 1. Knoten des Steilchens ist auch oben meist weniger winklig, oder sogar etwas depress und abgerundet. Die Farbe der amerikanischen Exemplare ist meistens ziemlich dunkel, schmutzig braun-roth, Kopf und Hinterleib schwärzlich.—Was aber diese Form von *lobicornis* besonders unterscheider lässt sind die Fühler des ♂. Der Schaft ist dick und kurz, kürzer als bei *sabuleti* und selten länger als ¼ der Geissel, bei den meisten, europäischen Exemplaren etwas kürzer, nahe der Basis stumpf geknickt."

Habitat.

According to Emery *Myrmica schencki* occurs in Central Europe in flat and hilly country, extending eastwards to China and Manchuria[2]. It has also been recorded from the Northern States of America[3], Belgium[4], Russia[6], Switzerland[7], and occurs in Wales.

British distribution as at present known:—

Glamorgan: Sully (*Hallett*).

Wicklow: Magherabeg (*Stelfox*).

A colony of this ant was discovered by Mr. H. M. Hallett at Sully in Glamorgan, on May 30th, 1915. He, however, took it to be *lobicornis*, and knowing I had plenty of the latter from various parts, did not send it to me at once. On October 25th, however, he wrote to me to say he was sending "☿☿ and ♀♀ of the *Myrmica lobicornis*, taken at Sully," and he mentioned that "the transverse ridge on the antennae of the ant looks unusually developed." On examining them I at once recognized that they were *Myrmica schencki* Emery, a form not known to have occurred in Britain before, and introduced it into our list[8]. On July 25th he visited the colony again and captured several winged females, but no males were present. The nest was situated in a bank of stiff marly soil, the entrance being a small round hole, much as is made by the smaller bees (*Halictus*, etc.). On September 15th, 1916, I visited this bank, in company with Mr. Hallett, and after some search three colonies were found in different parts of it. Evidently the marriage-flight had occurred previously, as no winged females were found, and only worker pupae and larvae were present. Two males, however, were secured, and a deälated female and a number of workers were collected alive for observation purposes. The only myrmecophile present was *Cyphodeirus albinos*.

This small live colony was kept under observation in a "Janet" nest for many months, but eventually, as the female did not lay any eggs, she was killed and placed in my collection.

Mr. A. W. Stelfox captured a single deälated female which was running about in the sun with plenty of *scabrinodis* workers on a sandy cliff in Co. Wicklow on May 2nd, 1926.

As to whether *schencki* should be regarded as a good species, subspecies, or variety, is really not of much value, as in any case it is a quite distinct form, and all the individuals in a colony are alike. Emery[13] considered it to be a subspecies of *scabrinodis*, and Forel[7] is of the same opinion, though he prefers his old name "race" to "subspecies." Emery formerly treated *lobicornis* as a subspecies of *scabrinodis*; but both he and Forel eventually considered it to be a good species. In 1910 Wheeler[3] calls *scabrinodis* a subspecies of *M. rubra* L., and *schencki* a var. of *scabrinodis*; but in 1911 he writes [Journ. New York Ent. Soc. **19** 163 (1911)]:—"*Myrmica rubra* or some one of the closely allied species (*scabrinodis levinodis, rugulosa*, etc.), which were formerly regarded as mere subspecies." I prefer to follow this latter view.

STENAMMA Westwood.

[στενός, narrow; ἅμμα, connection (i.e. the petiole).]

Type: **Stenamma westwoodi** (Steph.) West.; West., 1840.

The genus *Stenamma* is common to the Palaearctic Region proper, and the Nearctic Region. Its origin is probably not boreal;

it is not found in India, but occurs in Africa. The species are predaceous; they prefer damp places, and are generally found singly. We only possess one species in Britain—*S. westwoodi* West.

☿ *Head* long oval, longer than broad; *clypeus* furnished with two fine longitudinal carinae, the space between which being somewhat hollowed out; *frontal carinae* short, divergent; *frontal area* deeply impressed, longer than broad; *mandibles* large, terminal border furnished with eight or nine teeth, which are shorter and blunter posteriorly; *maxillary palpi* four-jointed; *labial palpi* three-jointed; *antennae* twelve-jointed, the first joint of the *funiculus* is long, those immediately following being short and transverse, the last joint is about equal in length to the three preceding taken together, and with them forms a not very distinct club; *eyes* small, point-like. *Thorax* with shoulders rounded; the division between the pronotum and mesonotum is obliterated, that between the mesonotum and epinotum being distinctly marked; *epinotum* armed with two sharply pointed triangular teeth. *Petiole* with a long shaft anteriorly, nodiform posteriorly; *post-petiole* nodiform; *gaster* oval, with very long first segment.

♀ Very like the ☿, a little larger; *eyes* larger; *ocelli* present. *Thorax* short and not high. *Fore-wings* with one cubital cell and one discoidal cell.

♂ *Head* longer than broad; *mandibles* broader with four to five teeth on the terminal border, or narrower with only three teeth; *antennae* thirteen-jointed, *scape* as long as the three following joints taken together, *funiculus* with a not very distinct four-jointed club, the last joint of which is a little longer than the two preceding taken together; *eyes* large, situated anteriorly. *Thorax* not very high; *mesonotum* with Mayrian furrows; *epinotum* with two teeth. *Pedicel* as in the ☿. *Wings* as in the ♀.

Ovum: White, opaque, shining, longer than broad, somewhat parallel-sided, rounded at each end; rather large for the size of the insect.

Larva: Greyish white, head pale yellow, mandibles reddish; covered *all over* with short anchor-tipped golden hairs. Plainly segmented to within a third of the posterior end; the head and three thoracic somites bent over posteriorly towards the ventral surface. Head flat, rounded, with short very pointed mandibles; abdomen pyriform.

Pupa: White, very compact, as if carved out of camphor; facets of eye red; gaster transversely striate. Changing to pale yellow and then nearly fully coloured before emergence.

Original description [Westwood Intro. Mod. Class. Insect 2 Synop. 83 (1840)]:—

"Stenamma *Westw.* N.G. 92 Steph. Cat. 1 sp. N.G. *Westwoodii* Steph. Basal joint of antennae long; abdominal peduncle two-jointed, first joint long, knotted; max. palpi four-jointed, labial three-jointed; mandibles broad, oblique, five-dentate. My Fig. 86 11."

Stenamma westwoodi West.

Stenamma westwoodii (Stephens) Westwood Introd. Mod. Class. Insect. **2** 226 Synopsis 83 (1840) ♂[1]. *Myrmica lippula* Nylander Acta. Soc. Sc. Fenn. **3** 41 (1849) ☿[2]. *Myrmica debilis* Förster Hym. Stud. **1** 52 (1850) ♂[3]. *Myrmica minkii* Förster Hym. Stud. **1** 63 (1850) ☿[4]. *Formica graminicola* F. Smith Proc. Ent. Soc. London (n.s.) **1** 82 (1851) ♀[5]. *Myrmica laeviuscula* Schenck Jahr. Ver. Naturk. Nassau **8** 132 (1852) ♂[6]. *Myrmica graminicola* Curtis Trans. Linn. Soc. Lond. **21** 216 (1854) ☿[7]. *Stenamma westwoodii* Curtis Trans. Linn. Soc. Lond. **21** 217 (1854) ♂[8]. *Myrmica graminicola* F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 126 (1855) ☿ ♀[9]. *Stenamma westwoodii* F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 134 (1855) ♂[10]; Westwood (Proc. Ent. Soc. Lond.) Zool. **13** 4747 (1855) ♂[11]; Proc. Ent. Soc. Lond. (n.s.) **3** 92 (1855) ♂[12].

Myrmica minki Mayr Verh. Zool. Bot. Ver. Wien **5** 415 (1855) ☿ ♀[13]. *Formicoxenus nitidulus* Mayr Verh. Zool. Bot. Ver. Wien **5** 418 (1855) ♂[14]. *Myrmica* (*Tetramorium*) *lippula* Nylander Ann. Sc. Nat. Zool. (4) **5** 88 (1856) ☿[15]. *Myrmica* (*Stenamma*) *nitidula* Nylander Ann. Sc. Nat. Zool. (4) **5** 94 (1856) ♂[16]. *Myrmica lippula* F. Smith Proc. Ent. Soc. Lond. (n.s.) **4** 88 (1857)[17] : Ent. Ann. **1858** 39[18]. *Myrmica* (*Tetramorium*) *lippula* F. Smith Cat. Brit. Foss. Hym. 28 (1858) ☿ ♀[19]. *Myrmica* (*Stenamma*) *westwoodii* F. Smith Cat. Brit. Foss. Hym. 32 (1858) ♂[20]. *Myrmica* (*Tetramorium*) *lippula* F. Smith Trans. Ent. Soc. Lond. (n.s.) **4** 279–280 (1858) ☿ ♀[21]. *Myrmica* (*Stenamma*) *westwoodii* F. Smith Trans. Ent. Soc. Lond. (n.s.) **4** 281 (1858) ♂[22]. *Myrmica lippula* F. Smith Proc. Ent. Soc. Lond. (n.s.) **4** 1857 89 (1858)[23] : Ent. Ann. **1860** 92[24]. *Myrmica nitidula* Meinert Kong. Danske. Vidensk. Selsk. Skrift. **5** 328 (1861) ♂[25]. *Myrmica lippula* F. Smith Ent. Ann. **1861** 42[26]. ? *Tetramorium lippulum* Mayr Europ. Formicid. 61–62 (1861) ☿ ♀[27]. *Asemorhoptrum lippulum* Mayr Europ. Formicid. 76 (1861)[28]. *Myrmica lippula* F. Smith Ent. Ann. **1863** 59[29] : **1864** 111 ♂[30]. *Tetramorium lippula* F. Smith Ent. Ann. **1864** 112[31] : Ent. Mo. Mag. **2** 29 (1865)[32]. *Asemorhoptrum lippulum* v. Hagens Verh. Nat. Ver. Preuss. Rheinl. **24** 50 (1867)[33] : Berlin Ent. Zeitschr. **11** 102 (1867)[34] : **12** 268 (1868)[35] ; Forel Denkschr. Schweiz. Ges. Naturw. **26** 80 (1874) ☿ ♀[36]. *Stenamma westwoodi* Forel Denkschr. Schweiz. Ges. Naturw. **26** 82 (1874) ♂[37]. *Stenamma westwoodii* Capron Entom. **11** 274 (1878)[38]. *Stenamma westwoodi* Saunders Trans. Ent. Soc. Lond. **1880** 216 ♂[39]. *Asemorhoptrum lippula* Saunders Trans. Ent. Soc. Lond. **1880** 217 ♂ ♀ ☿[40]. *Tetramorium lippula* Parfitt Trans. Devon Assn. Sc.-Art. **12** 516 (1880)[41]. *Stenamma westwoodi* Er. André Spec. Hym. Europe **2** 312 (1881) ☿ ♀ ♂[42]. *Tetramorium lippula* Bridgman Trans. Norf. Norwich Nat. Soc. **3** 367 (1882)[43]. *Stenamma laeviuscula* Stolpe Entom. Tidskr. **3** 146 (1882) ☿ ♀[44]. *Stenamma westwoodi* Saunders Ent. Mo. Mag. **20** 16, 19 (1883)[45]. *Tetramorium lippula* Capron Ent. Mo. Mag. **22** 264 (1886)[46]. *Stenamma westwoodi* Frisby Ent. Mo. Mag. **26** 82 (1890)[47] ; Wasmann Tijdshr. Entom. **34** 52 (1891)[48] : zusam. Nest. u. gemischt Kolon. Ameisen 256 (1891)[49]. *Stenamma westwoodii* Rothney Ent. Mo. Mag. **27** 79 (1891)[50]. *Stenamma westwoodi* Perkins Ent. Mo. Mag. **27** 123 (1891)[51]. *Stenamma westwoodii* Fryer Entom. **25** 50 (1892)[52] ; Dalla Torre Cat. Hym. **7** 121 (1893)[53]. *Stenamma westwoodi* Wasmann Krit. ver. Myr. u. Ter. Art. 162 (1894)[54]. *Tetramorium lippulum* Farren-White Ants' Ways 243 (1895) ☿ ♀[55]. *Stenamma westwoodii* Farren-White Ants' Ways 245 (1895) ♂[56]. *Stenamma westwoodi* Tuck. Ent. Mo. Mag. **32** 155 (1896)[57] ; Saunders Hym. Acul. 35 (1896)[58] ; Morley Entom. **31** 13 (1898)[59] : Hym. Suffolk **2** 2 (1899)[60]. *Stenamma westwoodii* Vic. Hist. Worcester **1** 86 (1901)[61]. *Stenamma westwoodi* Donisthorpe Ent. Rec. **14** 16 (1902)[62] ; Chitty Ent. Mo. Mag. **39** 284 (1903)[63] ; Vic. Hist. Cornwall **1** 182 (1906)[64] ; Escherich Ameise 215 (1906)[65] ; Scharff Europ. Animals 70 (1907)[66] ; Vic. Hist. Kent **1** 116 (1908)[67] ; Emery Deutsch. Ent. Zeitschr. **1908** 306[68] ; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 226 (1908)[69] : Ent. Rec. **21** 258 (1909)[70] : Entom. **44** 390 (1911)[71] ; Emery Rev. Suisse Zool. **21** 582 (1913)[72] ; Frisby Ent. Mo. Mag. **51** 313 (1915)[73] ; Emery Bull. Soc. Ent. Italiana **47** 127 (1916)[74] ; Donisthorpe Ent. Rec. **31** 1 (1919)[75] ; Emery Gen. Ins. **174** 53 (1921)[76] ; Phillips Irish. Nat. **30** 125–7 (1921)[77] ; Stelfox Ent. Rec. **34** 43 (1922)[78] ; Hodson Entom. **55** 281 (1922)[79] ; Hallett Cardiff Nat. Soc. **52** 53 (1922)[80] ; Donisthorpe Ent. Rec. **34** 2 (1922)[81] : **35** 2 (1923)[82].

☿ *Lighter or darker reddish yellow, antennae, legs and gaster beneath, lighter, sometimes the head, thorax and pedicel above, and the disc of the gaster are brownish; head and thorax with short, pedicel and gaster with longer, scattered pale hairs. Head* with front longitudinally striate, the rest distinctly reticulate ; *clypeus* in centre, and *frontal area* smooth and shining. *Thorax* strongly rugose ; *epinotum* posteriorly smooth and shining. *Pedicel* finely wrinkled longitudinally ; *gaster* smooth and shining. *Long.* 3·5–4 mm, (3–3·7 mm, *teste Emery*.)

♀ *Lighter or darker reddish brown, variable as in the* ☿. *Characters as in the* ☿. *The reticulation of the head is not nearly so marked in some specimens. Wings* dirty pale yellow, with light brown pterostigma and nerves. *Long.* 4·3–4·8 mm. (4–4·6 mm. *teste Emery* ; 5 mm. *teste André.*)

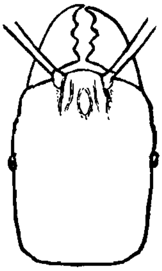


Fig. 75. Head of *Stenamma westwoodi* ☿.

♂ *Blackish brown, mandibles, antennae, and legs brownish yellow, apex of antennae, tarsi, and articulations of the joints of the legs lighter. Head* longitudinally striate, dull ; *frontal area* smooth and somewhat shining. *Thorax*

Fig. 76. *Stenamma westwoodi* ☿.

a little less strongly striate, and a little more shining than head ; *epinotum* with sides finely striate, shining above and posteriorly. *Petiole* and *post-petiole* above, and *gaster* smooth and shining. *Wings* as in the ♀. *Long.* 4 mm. (3·5 mm. *teste Emery.*)

Habitat.

Stenamma westwoodi occurs in South and Central Europe ; a variety has been described from Italy, and a subspecies from Turkestan. Scharff writes[66]—" It has been found in the south-west of Ireland and in the south of England ; nowhere else in the British Isles." As we shall see, however, it occurs as far north as the Midlands and Norfolk (Malloch's record of its capture by Taylor in the Clyde Area was in error, since, as pointed out by Evans [Glasgow Nat. **4** 21 (1911)], it really refers to *Myrmica ruginodis* :—

Cornwall, W. : The Lizard (*H. C. Champion*) ; Truro[64] ; **Cornwall, E. :** Mount Edgcumbe (*Dale*)[58].

Devon, S. : Plymouth (*Reading*)[17] ; Bickleigh (*Bignell*)[53] ; Dartmouth (*Perkins*)[51] ; Labrador, Shaldon (*Rothney*)[50] ; Seaton

(*Dale*)[58] ; **Devon, N. :** Ilfracombe (*Saunders*)[58] ; Clovelly (*Dale*)[58] ; Lynton (*Farren-White*)[55].

Somerset, N. : Weston-super-Mare (*Donisthorpe*)[69].

Wilts, S. : Dinton near Wilton (*Curtis*)[7].

Dorset : Godmanstone (*Dale*)[58] ; Corfe Castle (*F. Smith*)[30] ; Studland (*Donisthorpe*)[69] ; Bloxworth[75] (*O. P. Cambridge*).

Isle of Wight : Blackgang Chine (*Curtis*)[8] ; Freshwater (*Dale*)[58] ; Parkhurst Forest (*Donisthorpe*)[70].

Hants, S. : Portsmouth (*Reading, Brit. Mus. Coll.*) ; New Forest (*D. Sharp, Camb. Mus. Coll.*).

Sussex, W. : Chichester (*Harwood*) ; **Sussex, E. :** Ditchling (*Donisthorpe*)[69].

Kent, E. : Maidstone (*Frisby*)[47] ; Doddington (*Chitty*)[63] ; Deal (*Dale*)[58] ; **Kent, W. :** Tunbridge Wells (*Dale*)[40] ; Charlton (*Farren-White*)[55] ; Darenth Wood (*Donisthorpe*)[70] ; Gravesend (*Frisby*)[73] ; Brasted (*Harwood*).

Surrey : Lambeth[19] and Vauxhall[9] (*Wing*) ; Richmond Park[69], Box Hill, and Oxshott[62] (*Donisthorpe*) ; Esher (*Arnold*) ; Woking and Chobham[40] (*Saunders*) ; Shere (*Capron*)[38] ; Weybridge (*F. Smith*)[7] ; Herne Hill (*Nixon*).

Essex, S. : Walthamstow, Chingford, and Epping Forest (*E. A. Butler*).

Herts : Letchworth (*E. A. Butler*).

Middlesex : Paddington[9] and Highgate[29] (*F. Smith*) ; Enfield (*Pool* and *Donisthorpe*)[69] ; Winchmore Hill (*Hodson*)[79].

Berkshire : Tubney and Windsor Forest (*Donisthorpe*)[69].

Buckinghamshire : Bourne End (*Best Gardner*).

Suffolk, E. : Bentley Woods (*Morley*)[59] ; Barnby Broad (*Bedwell*) ; **Suffolk, W. :** Tostock (*Tuck*)[60].

Norfolk, E. : Near Norwich (*Bridgman*)[43].

Bedford : Sharpenhoe (*Hodson*).

Northampton : Helpston Heath (*Morley*).

Worcester : Hallow[61].

Warwickshire : Warwick (*Fryer*)[52].

Glamorgan : Cwrt-yr-ala (*Hallett*)[80].

Leicestershire : Ayleston (*S. O. Taylor*).

Wexford : Mount Garrett Wood, Camlin Wood, New Ross, and Killoughrim Forest (*Phillips*)[77].

Kilkenny : R. Barrow (*Phillips*).

Kerry : Kenmare Bay (*Halbert*)[69].

The greatest confusion formerly existed in the synonymy of this species, as its male was incorrectly treated as that of *Formicoxenus nitidulus*, and it was not until Er. André[42] first pointed out the error in 1881 that the matter was finally cleared up.

Stenamma westwoodi is a rare species of obscure habits ; according to André[42] it occurs in shady places in woods and forests,

nesting in the earth under moss and dead leaves, the nest being difficult to detect, and Mayr[27] states its habits are similar to those of *Leptothorax.* Nylander[15] records it in moss in the Forest of Fontainebleau, von Hagens[35] in all the woods at Cleve, single workers being found in moss and under leaves, and Wasmann[48] took it occasionally under leaves in Dutch Limburg.

Hallett took this ant in agarics at Cwrt-yr-ala in September and October, 1921[82], and in October, 1922, I also captured several workers at the roots of a fungus in the New Forest[82].

Forel[36] mentions that Emery discovered it at Prilly near Lausanne, and that they both took a number of workers at roots under dry leaves on the borders of a stream in a wood there in September, 1873, but no nest was found. I also captured a number of workers, in moss, in company with *Myrmica ruginodis,* on April 30th, 1905, at Ditchling in Sussex, but could not trace their nest.

Tuck records a specimen in a nest of *Bombus terrestris*[57] found at Tostock[60], and Farren-White the capture of a worker with a dead companion in its mandibles in the Valley of Rocks at Lynton[55].

Von Hagens[34] once found an independent colony at Elberfeld, consisting of a deälated female and workers, and Wasmann another, situated under a stone in a wood at Laacher See (Rheinischen Vordereifel) in August, 1889, some eighty workers and twelve males being present, no female, however, being found[48 49].

On the 20th May, 1921, Phillips[77] discovered two colonies each under a large flat stone in Mount Garret Wood near New Ross, Co. Wexford. The first consisted of about a dozen workers walking on the underside of the stone, which rested on a loose layer of dead twigs and leaves. The second was a small nest in which about twenty workers and some larvae were seen. In September of the same year he discovered one nest with numerous workers and larvae, and another with a few workers only in Killoughrim Forest, Co. Wexford. These habitats are old oak roots with a plentiful undergrowth of holly and brambles.

On September 17th Phillips and Stelfox visited Mount Garret Wood together, and in the space of a few hours examined over forty nests, most of which contained larvae, pupae, workers, and one or more queens. Males varying in numbers from one to eight were also present in some nests. The number of adult ants in each nest varied between twenty and two hundred. A few abnormal colonies were also found—one consisted of five males and one worker; another of one male and two workers, there were no larvae in either of these; a third had six deälated females, two workers, and some larvae. Every nest was situated under a stone, so tightly embedded as to preclude light and moisture; usually

in the centre when the stone was flat; or in the most inaccessible place when the stone was angular. The structure of the nests consisted of a central chamber roughly circular or oblong, usually about one inch across, and a quarter of an inch in depth, with a few short side-galleries leading into subterranean passages, the whole roofed by the stone and covering a space of not more than two and a half inches square.

The central chamber in which the young brood lay was very carefully prepared, the floor being clean, level, and coated with a thin bluish grey material which, seen through a lens, had the appearance of a minute web-like fungus. It is probable that the exit and ventilation were through one or more of the narrow underground tunnels. Hodson[79] also found a number of colonies of this ant at Winchmore Hill in 1922; and Nixon at Herne Hill in 1926.

This *Stenamma* has been frequently taken with other ants; von Hagens speaks of it as presumably a guest-ant, the workers occurring preferably in, or near, other ants' colonies[33], and Escherich as commonly in the neighbourhood of other ants' nests[65].

André considers its occurrence in such situations as only accidental[42], and Wasmann is of the opinion that it is not a myrmecophilous species[54]; nevertheless the records with other ants appear to me to be too numerous to be treated as of purely accidental occurrence. F. Smith records its capture amongst a colony of *Formica fusca,* by Reading in July, 1857, near Plymouth[18]—twice in a nest of *Acanthomyops fuliginosus* by himself in 1859[24]—by Edwin Shepherd with the same ant in 1860[26], and he points out that E. W. Janson had taken it previously, also with the same *Acanthomyops*—in 1863 he writes—" This minute ant appears to be a constant resident in the nests of other species, at least in this country; whether it is found invariably in such situations throughout Europe I am not prepared to say, but I have never found it separated from other ants. Mr. Janson and also Mr. Shepherd find it in nests of *Formica fuliginosa.* I have also myself found it in company with the same species, but sparingly. In May last it occurred in some numbers in ants' nests near Highgate, but I have only been successful in taking workers; the only examples I have ever obtained of the other sexes are two females; one was taken on the wing in October, and the other on a Christmas Day, some years ago. I am inclined to believe that *M. lippula* never constructs its own nest, but resides constantly with species of *Formicidae.*"[29] In 1863 he found this species in some abundance in and in the vicinity of a nest of *Formica rufa*[31]. Von Hagens records workers at Cleve, chiefly with *Acanthomyops fuliginosus,* singly with *Formica sanguinea* and *A. brunneus*[34]. Parfitt found a worker in a nest of *F. rufa* in Devonshire[41]; Farren-White took it at Charlton in

company with *A. umbratus*[55], and Saunders near a nest of *F. rufa* and another of *A. fuliginosus* under dead leaves at Chobham in May, 1893[45 58]; Hallett found a worker in a mixed colony of *A. fuliginosus* and *A. mixtus* at Cwrt-yr-ala on May 29th, 1919[80]; and Phillips took a male and worker on the ground close to a nest of *Formica fusca* in September, 1921, in a wood at Camlin[77].

Wasmann records it for Dutch Limburg in the neighbourhood of nests of *A. umbratus*, *A. brunneus*, and *M. ruginodus*[48].

My own captures of this species in other ants' nests are as follows :—Seven specimens at different times in a nest of *A. fuliginosus* at Oxshott[62]—singly in a nest of *F. rufa* in Parkhurst Forest[70] (April 26th, 1909), and *A. fuliginosus* at Darenth Wood[70] (June 5th, 1909)—a worker in a nest of *A. mixtus* at Box Hill on May 23rd, 1913—and five workers with *A. fuliginosus* at Weybridge (September 7th and 12th, 1914). No winged forms, however, appear to have been found with other ants, as was also pointed out by von Hagens[34].

The winged forms occur late in the year, and the marriage-flight takes place in September and October.

Curtis captured a male at Blackgang Chine in the middle of October, 1829[8], Wing a female flying at Vauxhall on December 9th, 1850[5], and F. Smith two winged females at Paddington in September, 1854[9], and whilst sketching the ruins of Corfe Castle a male alighted on his sketch book[30], on October 6th, 1863.

Von Hagens records a marriage-flight at Elberfeld on October 15th, 1864[34]. Capron found a male at Shere on October 15th, 1878[38], Frisby took two winged females at rest on the inside of a half-opened window at Maidstone at the end of August or beginning of September, 1887[47], and a male in a lane near Gravesend on October 13th, 1915[73], and Saunders records the capture by himself of a male at Ilfracombe in September, and a number of specimens, taken by Dale in various localities, all winged and occurring in October[58]. I captured a winged female by evening sweeping on October 3rd, 1905, at Tubney, males and winged females at Enfield with Pool, in October, 1906, an isolated deälated female on the sand-hills at Studland on September 3rd, 1905, and a male by evening sweeping in Windsor Forest on September 21st, 1926.

Emery records two specimens in which the wings are abnormal —in the one, a female, in both fore-wings a nerve incompletely separates the cubital cell, as in *Myrmica ;* in the other, a male, the right fore-wing possesses a second cubital cell, small and detached from the radial cell[72].

Perkins records and describes a curious specimen of *Stenamma westwoodi* which he picked up while walking between Dartmouth and Stoke Fleming in October, 1890. It is an approximately materal ergatandromorph, the left side being worker, the right side male, and the gaster apparently worker. He described it as follows[51] :—

"Left Half. Head red, with darker cloud reaching from vertex to eye. Mandible very large with seven teeth. Antennae twelve-jointed, testaceous, with pale hairs; first joint of flagellum longer than next two together; these and the following joints much wider than long; apical joint very large and stout, as long as two preceding; scape very long and bent, as long as many joints of flagellum. Eye small. Mesothorax red. Second node of petiole lighter. Abdomen from middle line testaceous brown. Legs shorter and thicker.

"Right Half. Head dark brown. Mandible small (the ant being carded I cannot clearly make out the form of the right mandible). Antennae thirteen-jointed, dark, thin, with pale hairs; first joint of flagellum stouter than next, but subequal to it; the following joints all much longer than wide; apical joint as long as on left side, but not nearly so stout; scape short and straight, only about as long as two joints of flagellum, and *per se* barely half the length of that of left side. Eye larger; more than twice the size of the other, and much nearer to the base of antenna. Mesothorax dark, laterally with two rough projections, apparently *tegulae*. Second node of petiole darker. Abdomen from middle line dark brown. Legs longer and thinner.

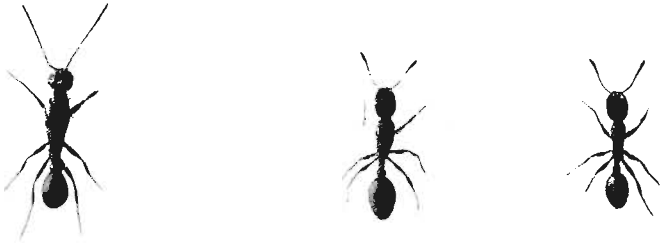
"The form of the abdomen, so far as I can make out in this specimen (set on card), is that of the ☿. The shape of the mesothorax is unsymmetrical bilaterally. Length about 3 mm."

This specimen is now in the Cambridge Museum.

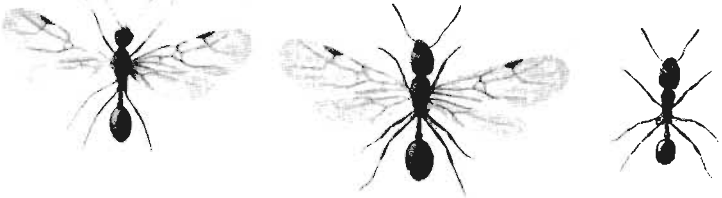
The following is a short account of a colony sent to me from Ireland by Phillips and Stelfox, which I have had under observation since 1921. The colony which consisted of a deälated female, some fifty workers, and a number of medium and large larvae, was fixed up in a four-chambered "Janet" nest on September 20th, 1921. The queen laid eggs on September 21st, and again between November 2nd and 7th. The workers "feign death" when touched, and at first they had a curious habit, when the cloth over the nest was raised and the colony disturbed by being exposed to the light, of rushing at a larva, seizing it, and apparently giving it a good shaking up! I found when touched that a larva will exude a drop of thick white fluid; it is probable that this is a means of defence, and possible that the worker shook up a larva to induce it to discharge this fluid. These ants devour flies and other insects readily, with bits of which they feed the larvae, as also with crumbs of cake, and biscuits; but do not appear to care much for honey. Two of the larvae, which had been removed from this nest to be photographed, were not returned to it for about a fortnight, when the workers would have nothing to do with them for a long time. Eventually they were placed with the rest of the brood. The larva is semi-transparent under the microscope, part of the alimentary canal, breathing apparatus, and nervous system being visible through the skin from the dorsal and ventral aspects; but not nearly so plainly through the sides. At the ventral posterior end of the body a white opaque mass can be seen through the skin, which is evidently of a liquid consistency, as when the larva is touched with a paint brush, a thick white drop of fluid is exuded from the anus, which either evaporates very quickly, or is partly received back

Plate VIII.

Male, female, and worker of *Leptothorax interruptus*.



Male, female, and worker of *Leptothorax acervorum*.



Male, female, and worker of *Stenamma westwoodi*.

into the body, leaving a thick white coating of the consistency of "Chinese White" on the anal surface of the larva.

Not a single ant of the original colony died in the first twelve months it was under observation. April 25th, 1922—the queen laid her first eggs for the year and continued laying throughout the summer. May 28th—a number of semipupae, some pupae, and one coloured pupa present. June 22nd—many light-coloured workers (callows), and one male hatched; workers continued to hatch during the summer, and a few callows died. October 10th—introduced a *Stenamma* worker from the New Forest, not much notice was taken of it by the workers in the nest. When it approached any of them they backed away from it; it walked over the larvae and endeavoured to make itself at home. I never saw it attacked, but a dead worker was present on October 13th in one of the light chambers which was probably the New Forest specimen. October 15th—several long Dipterous larvae given to the ants; the workers arranged their own larvae on them in rows, like so many little pigs feeding side by side at a trough. December 8th—some seventy-five workers, about one hundred larvae, and the queen-mother present. The ants have carried on in much the same way ever since; a male hatched on June 22nd, 1924; and two males on August 16th, 1925. Nearly two hundred workers, some larvae, two males and the queen-mother are now present. June 30th, 1926—the colony, in a flourishing condition is still under observation.

Cyphodeirus albinos is the only myrmecophile which has been found with this ant in Britain.

LEPTOTHORAX Mayr.

(λεπτός, slender; θώραξ, thorax.)

Type: **Leptothorax clypeatus** Mayr (Emery, 1912).

This is a large, widely distributed, homogeneous genus, its species being closely related to each other, and often only separated by somewhat trivial characters. It occurs in Europe, India, Japan, Africa, North America, etc., and comprises very agile, robust, and hard ants, which, however, are of a timid and adaptable temperament, and not at all warlike in nature. Their habits are singularly diverse, and they live in small communities nesting under stones, in the ground, under bark, in moss, in hollow twigs, in rotten branches, in galls and fallen nuts, in the borings of other insects, and between the laminae of stones, etc.

The queens are very little larger than the workers, at least in the large species, and their habits are very similar, both the winged and deälated females carrying about the larvae and pupae in their mandibles.

There is generally more than one fertile female in the same colony, and sometimes the virgin females remove their own wings

without leaving the nest. The marriage-flight is similar to that of the genus *Myrmica*, but too few males and females occur to enable it to be called a swarm.

A number of intermediate forms between the females and workers frequently occur, and both microgynes and ergatoid females are often present in the same colony with typical females.

When one of the workers is carried by another, it is seized by the mandibles and swung over the back of the carrier, with the dorsal surface uppermost.

These ants do not keep *Aphidae* in their nests, nor do they appear to seek them on plants, but they lick the leaves of trees and plants on which honey-dew has fallen.

Many species have a tendency to enter into more or less close symbiotic relations with other ants.

This is the only genus in which the ants are furnished with blunt hairs, which have been called " clubbed hairs," but which in any case are never pointed.

Wheeler designated *Formica acervorum* Fabricius as the type of the genus *Leptothorax* [Ann. New York Acad. Sci. **21** 166 (1911)], but Emery [Ann. Soc. Ent. Belg. **56** 271 (1912)] selects *L. clypeatus* Mayr, both because it was the first species described by Mayr, and because *L. acervorum* Nylander has already been made the type of the subgenus *Mychothorax* by Ruzsky.

☿ *Head* oblong, rounded posteriorly; *clypeus* triangular, concave or convex, transverse anteriorly; *frontal carinae* short, almost straight; *frontal area* somewhat impressed, not clearly defined; *mandibles* broad, terminal margin armed with four or five teeth; *maxillary palpi* five-jointed; *labial palpi* three-jointed; *antennae* eleven-, or twelve-jointed, first joint and last three joints of *funiculus* longer than broad, the latter forming a distinct club about as long as the rest of the funiculus, its last joint being equal in length to or a little longer than the two preceding taken together. *Thorax* long and narrow; *pronotum* rounded anteriorly; suture between pronotum and mesonotum wanting, between mesonotum and epinotum marked, or wanting; *epinotum* armed with two teeth, or spines. *Petiole* cylindrical anteriorly, nodiform posteriorly; *post-petiole* nodiform; *gaster* oblong oval; *sting* large.

The body is furnished with short, scattered, blunt hairs.

♀ Very like the ☿; *gaster* longer oval. *Wings* very pale; *fore-wings* with one cubital cell, and one discoidal cell.

♂ *Head* triangular; *mandibles* narrow, flat, unarmed, or furnished with four or five teeth; *antennae* twelve-, or thirteen-jointed; *mesonotum* with more or less distinct Mayrian furrows; *epinotum* armed with two tubercles. *Wings* as in the ♀.

Ovum: White, round oval.

Larva: Whitish yellow, slightly pyriform, but the posterior segments not much wider than the anterior ones, clothed with longer and shorter hairs, which are more abundant on the younger larvae. The first to the sixth abdominal segments furnished with a pair of long anchor-tipped hairs, on the dorsal surface.

Pupa: Yellow, wax-like, colour of adult when mature.

Original description [Mayr Verh. Zool. Bot. Ver. Wien 5 431 (1855)] :—

"*Leptothorax* Mayr n.g.

(λεπτός schlank, θώραξ Brust.)

Arbeiter. Der feingerunzelte Kopf ist langer als breit und breiter als der Thorax. Die Oberkiefer sind breit und gezähnt. Die Unterkiefertaster sind fünfgliedrig, deren letztes Glied ist das längste von allen. Die Lippentaster sind dreigliedrig. Die Oberlippe ist in der Mitte des Vorderrandes schwach stumpwinklig ausgerandet. Der Clypeus ist sehr wenig gewölbt oder vorne concav, bei einer Art undeutlich gezähnt. Die Fühler sind eilf- bis zwölfgliedrig. Die Punctaugen sind wohl meist vorhanden, aber oft sehr undeutlich, ebenso das Stirnfeld. Die Netzaugen sind nicht klein. Der fein gerunzelte und schlanke Thorax is vorne am breitesten und verschmälert sich allmählig nach hinten, er ist oben zwischen dem Meso- und Metanotum nicht eingeschnürt, sondern bloss mit einer Furche versehen. Das Metanotum trägt zwei horizontal nach hinten oder schief nach hinten und aufwärts gerichtete Dornen. Das erste Glied des Stielchens ist vorne kurz stielförmig, hinten knotenförmig ; das zweite Glied ist knotenförmig unten nicht bedornt, der Knoten ist so lang als breit und etwas niedriger als der erste Knoten. Der Hinterleib ist rundlich oder oval und über drei Viertheile desselben werden von seinem erstem Segmente bedeckt.

Weibchen. Der Kopf ist mit Ausnahme der Punct- und Netzaugen so wie beim ☿. Der Thorax ist von vorne bis zur Mitte ziemlich gleichbreit oder nur unbedeutend in der Mitte breiter. Das Mesonotum ist stark abgeflacht. Das mit zwei horizontal nach hinten oder nach hinten und aufwärts gerichteten Zähnen oder Dornen versehene Metanotum vermehrt die Länge des Thorax um seine eigene Länge und hat eine nur wenig nach abwärts geneigte Basalfläche. Das Steilchen ist so wie beim ☿, nur ist der zweite Knoten meist unbedeutend breiter als lang. Der Hinterleib ist ei- oder langlicheiförmig, und wenigstens zwei Drittel desselben werden von seinem ersten Segmente bedeckt. Die Flügel sind milchweiss oder sehr schwach gelblich, ebenso deren Rippen. Die Costa transversa verbindet sich mit der Costa cubitalis an deren Theilungsstelle, wodurch bloss eine einzige geschlossene Cubitalzelle entsteht ; der innere Cubitalast ist oft nicht deutlich ausgebildet ; die geschlossene Discoidalzelle ist vorhanden.

Männchen. Der Kopf ist kurz und breiter als der Thorax. Die Oberkiefer sind nicht breit, gezähnt oder ungezähnt. Der Clypeus ist schwach gewölbt. Der Schaft der zwölf- bis dreizehngliedrigen Fühler ist kurz, die Geissel ist fadenförmig. Die Punctaugen sind gross, die Netzaugen stehen stark hervor. Das Mesonotum ist mit zwei nach hinten convergirenden Linien versehen. Der Metathorax ist nicht verlängert und das Metanotum ist mit zwei Beulen, selten mit zwei sehr kurzen Zähnchen versehen. Das erste Glied des Stielchens ist hinten knotenförmig verdickt und nach vorne conisch zulaufend ; das zweite Glied ist knotenförmig. Das erste Segment des Hinterleibes bedeckt etwa zwei Drittel des letzteren. Die Flügel sind so wie beim ♀ gebildet."

Table of the Species.

☿

1	Antennae twelve-jointed	2
–	Antennae eleven-jointed (subgen. *Mychothorax* Ruzsky)	1 *acervorum* F.
2	Club not darker than the rest of antenna	3
(1)	Club darker than the rest of antenna	4
3	An impression between mesonotum and epinotum ; spines long	2 *nylanderi* Först.
(2)	No impression between mesonotum and epinotum ; spines short	3 *corticalis* Schen.
4	Epinotal spines longer, curved	5 *interruptus* Schen.
(2)	Epinotal spines shorter, not curved	4 *tuberum* F.

♀

1 { Antennae twelve-jointed 2
– { Antennae eleven-jointed – – – – – – – – – – – – – – – – – – – *acervorum* F.
2 { Club not darker than the rest of antenna 3
(1) { Club darker than the rest of antenna – – – – – – – – – – – – – – – – – – 4
3 { Gaster banded; spines long . . . . *nylanderi* Först.
(2) { Gaster not banded; spines short – – – – – – – – – – – – *corticalis* Schen.
4 { Scutellum striate; spines shorter . . . . *tuberum* F.
(2) { Scutellum smooth and shining in centre; spines longer – *interruptus* Schen.

♂

1 { Antennae thirteen-jointed 2
– { Antennae twelve-jointed – – – – – – – – – – – – – – – – – – *acervorum* F.
2 { Mesonotum smooth and shining between the Mayrian furrows 3
(1) { Mesonotum not smooth and shining between the Mayrian furrows – – – 4
3 { Epinotum armed with small tubercles . . . . *corticalis* Schen.
(2) { Epinotum without or with very faint tubercles – – – *nylanderi* Först.
4 { Joints 2–5 of funiculus as broad as long . . . . . . *interruptus* Schen.
(2) { Joints 2–5 of funiculus longer than broad – – – – – – – – – – *tuberum* F.

Leptothorax acervorum F.

Formica acervorum Fabricius Ent. Syst. 2 358 (1793)[1]. *Formica rubra* var. *acervorum* Latreille Hist. Nat. Fourmis 250 (1802)[2]. *Formica graminicola* Latreille Hist. Nat. Fourmis 255 (1802) ☿[3]. *Myrmica acervorum* Zetterstedt Insect. Lappon. 1 451 (1838) ☿ ♀[4]. *Myrmica lacteipennis* Zetterstedt Insect. Lappon. 1 452 (1838) ♂[5]. *Myrmica acervorum* Curtis Trans. Linn. Soc. Lond. **21** 215 (1854)[6]; F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 124–125 (1855)[7]. *Leptothorax acervorum* Mayr Verh. Zool. Bot. Ver. Wien **5** 436 (1855)[8]. *Myrmica* (*Leptothorax*) *acervorum* F. Smith Brit. Foss. Hym. 29 (1858)[9]: Trans. Ent. Soc. Lond. (n.s.) **4** 1857 280 (1858)[10]. *Leptothorax acervorum* Forel Denkschr. Schweiz. Ges. Naturw. **26** 84 341 403 (1874)[11]; Cameron Proc. NH. Soc. Glasgow **2** 294 (1876)[12]: **3** 90 (1876)[13]: **3** 105 (1877)[14]. *Myrmica* (*Leptothorax*) *acervorum* Service Scot. Nat. **5** 63 (1879)[15]. *Leptothorax acervorum* Parfitt Trans. Devon Assn. Sc.-Art. **12** 516 (1880)[16]; Saunders Trans. Ent. Soc. Lond. **1880** 219[17]; Er. André Hym. Europe **2** 294 (1881)[18]; Dale Ent. Mo. Mag. **17** 236 (1881)[19]; Rothney Ent. Mo. Mag. **18** 262 (1882)[20]; Bridgman Trans. Norf. Norwich Nat. Soc. **4** 690 (1889)[21]; Wasmann Stett. Ent. Zeit. **51** 309 (1890)[22]: zusam. Nest. gemischt. Kolon. Ameisen 8 (1891)[23]; Rothney Ent. Mo. Mag. **28** 50–51 (1892)[24]; W. Gardner Brit. Nat. **2** 23 (1892)[25]; Dalla Torre Cat. Hym. **7** 122 (1893)[26]; Rothney Ent. Mo. Mag. **29** 67–68 (1893)[27]; Farren-White Ants' Ways 171 243–244 (1895)[28]; Carpenter Irish Nat. **4** 257 (1895)[29]; Wasmann Biol. Centralb. **15** 618–619 (1895)[30]; Saunders Hym.-Acul. 37 (1896)[31]; Service Scott-Elliott's Flora Dumfriesshire XV (1896)[32]; Johnson Irish Nat. **6** 57 (1897)[33]; Cuthbert Irish Nat. **7** 67[34] 209[35] (1898); Morley Hym. Suffolk **2** 2 (1899)[36]; Saunders Ent. Mo. Mag. **36** 14 (1900)[37]; Donisthorpe Ent. Rec. **12** 176 (1900)[38]; Vic. Hist. Cumberland **1** 103 (1901)[39]; Malloch Fauna, Flora, Geol. Clyde Area 219 (1901)[40]; Carter Ent. Mo. Mag. **37** 67 (1901)[41]; Donisthorpe Ent. Rec. **14** 16 (1902)[42]; Saunders Irish Nat. **12** 68 (1903)[43]; Jordain Trans. N-Staff. Nat. Field Club **17** 82 (1903)[44]; Vic. Hist. Sussex **1** 131 (1905)[45]; Harwood Ent. Mo. Mag. **41** 117 (1905)[46]; Vic. Hist. Berks **1** 76 (1906)[47]; Vic. Hist. Cornwall **1** 182 (1906)[48]; Rothney Ent. Mo. Mag. **42** 14 (1906)[49]; Donisthorpe Ent. Rec. **18** 317 (1906)[50]; Escherich Ameise 218 (1906)[51]; Frisby Proc. Holmesdale NH. Club **1906** 74[52]; Vic. Hist. Kent **1** 116 (1908)[53]; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 227 (1908)[54]; Morley Ent. Mo. Mag. **44** 215 (1908)[55]; Silverlock Nat. **1910** 13[56]; Wasmann Biol. Centralb. **30**

494–495 (1910)[57]; Donisthorpe Ent. Rec. **23** 11–12 (1911)[58]; Orr Irish Nat. **20** 76 (1911)[59]; Donisthorpe Entom. **44** 390 (1911)[60]: Ent. Rec. **24** 5 (1912)[61]; Evans Scot. Nat. **1912** 107[62]; J. Taylor Ent. Rec. **24** 65 (1912)[63]; Donisthorpe Ent. Rec. **25** 62–63 (1913)[64]: Rep. Lancs-Chesh. Ent. Soc. **36** 1912 54 (1913)[65]; Hallett Trans. Cardiff Nat. Soc. **45** 3 (1913)[66]; Crawley and Donisthorpe Int. Ent. Cong. Oxford **2** 1912 20 (1913)[67]; Donisthorpe Ent. Rec. **26** 38 (1914)[68]; Crawley Ent. Rec. **26** 91, 95, 97 (1914)[69]; Stainforth Nat. **1915** 390[70]; Crawley Proc. Somerset A. N. H. Soc. **62** 145 (1916)[71]. *Leptothorax* (*Mychothorax*) *acervorum* Emery Bull. Soc. Ent. Italiana **47** 176 (1916)[72]. *Leptothorax acervorum* Johnson Irish Nat. **28** 7 (1919)[73]; Donisthorpe Ent. Rec. **31** 2[74] 21[75] (1919). *Leptothorax* (*Mychothorax*) *acervorum* Emery Gen. Ins. **174** 261 (1922)[76]. *Leptothorax acervorum* Donisthorpe Ent. Rec. **34** 83 Pl. II fig. 6 (1922)[77]: **35** 2 (1923)[78].

☿ *Reddish yellow with the head, club of antennae, and dorsal surface of the gaster darker, occasionally the whole body is yellow, the darker parts being only slightly darker, or brown with the darker parts brownish black.*

Head longitudinally striate; *clypeus* somewhat concave, smooth and shining; *antennae* eleven-jointed, *club* blackish. *Thorax* more or less rugose; suture between mesonotum and epinotum distinct; *epinotal spines* moderately long. *Petiole* and *post-petiole* very finely rugose; *gaster* smooth and shining. *Legs*: tibiae with erect hairs. *Long.* 3·4–4·5 mm. (3·3–3·7 mm. *teste Forel.*)

♀ *Very like the* ☿, *generally darker in colour, mesonotum often red with black patches.*

Antennae eleven-jointed. *Tibiae* with erect hairs. *Wings* white, the radial cell open. *Long.* 4–4·8 mm. (3·5–4·2 mm. *teste Forel.*)

♂ *Black, or brownish black; tibiae and tarsi and the articulations of the legs yellow.*

Head rugose; *antennae* twelve-jointed, the joints of the funiculus only broader at the apex, and not forming a distinct club, second joint of funiculus longer than the scape. *Thorax* rugose. *Petiole* finely longitudinally striate; *post-petiole* and *gaster* smooth and shining. *Wings* as in the ♀. *Long.* 4·8–5 mm. (3·7–4·8 mm. *teste Forel.*)

Original description of *Formica acervorum* Fabricius [Ent. Syst. **2** 358 (1793)] :—

" F. rufa capite abdomineque nigris, thorace postice bispinoso, petiolo binodi.

Habitat in Daniae nemoribus Mus. Dom. de Schestedt.

Nimis certe affinis F. tuberum. Caput nigrum antennis mandibulisque rufis. Thorax rufus dorso nigro postice spinis duabus porrectis, validis, acutis. Petiolus ferrugineus, binodis. Abdomen glabrum, atrum, immaculatum. Pedes ferruginei."

Habitat.

Leptothorax acervorum ranges over the whole of Europe except in the extreme south, and Ruzsky records it from Siberia and Turkestan.

Its distribution in the British Isles is as follows :—

Cornwall, E. : Near Looe[48].

Devon, S. : Bovey Tracey[58] (*Hamm*); Dawlish (*Parfitt*)[16]; **Devon, N.** : Lynmouth and East Lynn (*Farren-White*)[28]; Woolacombe Sands (*Parfitt*)[16].

Somerset, S. : Porlock (*Crawley*)[71].

Wilts, N. : Sopwith (*Perkins, Cambridge Mus. Coll*.).

Dorset : Glanvilles Wootton[7] and Lulworth[7] (*Dale*); Morden, Upper Rockhampton, Puddletown Heath, Tadnoll, and Redbridge (*Haines*); Bloxworth (*O. P. Cambridge*).

Isle of Wight : Parkhurst Forest (*J. Taylor*)[63].

Hants, S. : New Forest[7] (*Dale*); Bournemouth (*Farren-White*)[28]; Eastleigh (*Killington*); **Hants, N.** : Harewood Forest (*Harwood*).

Sussex, W. : Harting[37] (*Beaumont*); **Sussex, E.** : Guestling[45] and Bexhill[45] (*Frisby*); Fairlight[38] and Camber Sands[61] (*Donisthorpe*).

Kent, E. : Hollingbourne[53]; Maidstone[31] (*Frisby*); Thurnham (*Frisby*)[53]; Throwley[53] (*Chitty*).

Kent, W. : Birchwood (*Power, Rothney Coll.*); Darenth Wood (*Donisthorpe*).

Surrey : Shirely (*F. Smith*)[7]; near Croydon (*Saunders*)[17]; Box Hill (*King*); Nutfield Marsh (*Frisby*)[52]; Weybridge (*Donisthorpe*)[42]; Woking (*Saunders*)[31]; Woodham (*Morice*).

Essex, S. : Chingford and Loughton (*E. A. Butler*).

Middlesex : Enfield[50] (*Pool*).

Berks : Wellington College (*Farren-White*)[28]; Boar's Hill[47], Bagley Wood, and Tubney (*Hamm*); Greenham (*Harwood*); Windsor Forest (*Donisthorpe*).

Oxford : Shotover Hill (*Hamm*).

Bucks : Pollard's Wood, Chalfont St. Giles (*Elliman*).

Suffolk, W. : Brandon district[36] (*Perkins*); Norton Wood[36] (*Tuck*).

Norfolk, E. : Earlham (*Bridgman*)[21]

Hunts : Monk's Wood[55] (*Chitty*).

Northampton : Corby (*S. O. Taylor*).

Gloucester, W. : Stonehouse, Leonard Stanley, Haresfield, Buckstone near Staunton, and the Forest of Dean (*Farren-White*)[28]; Wotton-under-Edge (*Perkins*).

Hereford : Lydbrook Junction and Symond's Yat (*Farren-White*)[28].

Stafford : Colwich[44] (*Martineau*).

Glamorgan : Cwrt-yr-ala and Pontneathvaughan (*Hallett*)[66].

Brecon : Ystradfellte (*Hallett*).

Carmarthen : Carmarthen (*E. A. Butler*).

Lincoln, N. : Market Rasen (*Morley*).

Leicestershire : Buddon Wood and Owston Wood (*S. O. Taylor*).

Notts : Sherwood Forest (*Bedwell*).

Derby : Little Eaton (*Harwood*)[46].

Cheshire : Bidstone Hill, Birkenhead[25] (Burns); Delamere Forest (*Arnold*); West Kirby (*Hallett*).

Yorks, N.E. : Goathland (*Saunders's Coll.*); Normanby, Middlesbrough, and Stanghow (*Walsh*); Lythe (*E. A. Butler*); **Yorks, S.W.** : Keighley (*Butterfield*); Hebden Bridge (*Silverlock*)[56]; **Yorks, S.E.** : Holme on Spalding Moor (*Stainforth*)[70]

Durham : Chopwell (*Walsh*).
Northumberland, S. : West Allendale (*Hull*).
Cheviotland : Isle of Lindisfarne (*W. E. Sharp*).
Cumberland : Carlisle district[39] ; Cumrew Fell[39].
Dumfries : Mabie Woods (*Service*)[32].
Lanark : Coatbridge[64] (*G. Brown*) ; Giffnock (*Murphy*).
Peebles : Macbiehill (*Evans*)[62].
Haddington : Saltoun (*Evans*)[62].
Edinburgh : Salisbury Crags, Polton, Ravensnook near Penicuik, Bavelaw, Ravebrig-toll Moss, Kirknewton, Newpark, and Torduff (*Evans*)[62].
Linlithgow : Binny Craig (*Evans*)[62].
Fife and Kinross : Thornton and Blair Adam (*Evans*)[62].
Stirling : Near Falkirk (*Evans*)[62].
Perth, S. : Near Callander and Kelty Glen, Aberfoyle (*Evans*)[62] ;
Perth, Mid. : Comrie (*Carter*)[41] ; Fillans (*Rothney*)[49] ; Ben Lawers (*Cameron*)[14] ; Rannoch (*Donisthorpe*)[61].
Aberdeen, S. : Braemar (*Donisthorpe*)[58].
Elgin : Forres (*King*).
Easterness : Nethy Bridge (*Donisthorpe*)[54] ; Aviemore (*Champion*) ; Kingussie[13] and Strathglass (*Cameron*)[12].
Ebudes, N. : Isle of Skye (*R. B. Robertson*).
Ross, W. : Kintail (*Cameron*)[12].
Down : Newcastle (*F. X. King*).
Armagh : Rich Hill (*Orr*)[59].
Donegal : Portnow (*Johnson*)[73].
Louth : Carlingford[31] (*Johnson*).
Dublin : Howth (*Halbert*).
Wicklow : Bray Head (*Johnson*)[33].
Kilkenny : Abbeyleix Wood (*Phillips*).
Galway, W. : Lough Corrib (*Carpenter*)[29].
Tipperary, N. : Riskaleen (*Phillips*).
Kerry : Cromaglaun Mt. (*Cuthbert*)[35] ; Cloonee (*Halbert*)[35] ; Bull Mount, Killarney (*Morley*) ; Ballybunion (*Cuthbert*)[34] ; Rossbeigh[43] and Turner's Rock (*Donisthorpe*).

The colonies of *Leptothorax acervorum* are never very populous, and it nests under the bark of tree-stumps—oak and especially fir, etc.—but also under stones, where I have found it on the mountains at Rannoch and Braemar. Hallett observed it nesting in some numbers in fallen branches of *Ulex* at West Kirby. Parfitt states that this ant constructs little runs by the sides of walls[16], having found it in such situations at Dawlish ; and I once discovered it at Fairlight, near the " Lovers' Leap," in the cracks of a rock. It will also take advantage of the borings of other insects, Tuck having taken it on a post tenanted by the wasp *Odynerus sinuatus*[36] at Norton Wood in Suffolk, and I picked up a fallen " oak-apple "

at Weybridge on September 14th, 1912, which contained a small colony of *L. acervorum* consisting of a deälated female, seventy-three workers and some larvae[64]. On July 14th, 1922, I observed ants from a colony of this species coming out of and going into the burrows of *Scolytus pruni* high up in an old apple tree in an orchard at Darenth Wood[78].

André says it is an alpine or sub-alpine species[18], and Saunders speaks of it as chiefly a northern species in Britain[17], but it is equally common here in the south.

Forel points out that the alpine variety of *acervorum* is sometimes nearly entirely brownish black in colour, and lives under stones[11], Cameron records an almost black variety at Kintail[12], and I have recorded a colony of very dark-coloured specimens found under stones on a mountain at Rannoch[61].

Saunders states that the males and females appear in September[31]; they are, however, generally to be found much earlier in the year. Cameron recorded males on the top of Ben Lawers in July[14], Carter males and winged females at Comrie in the same month[41], and Schenck says that this species swarms in July, and that he found the first winged forms on July 5th at Nassau. Forel observed the copulation of this ant, on a wall on Mont Tendre in Switzerland, on July 30th, 1871[11].

I have found males at Nethy Bridge on June 19th, 1911, males and winged females in the same locality on July 24th, 1907, in the New Forest on July 22nd, 1912, and at Rannoch on July 15th, 1913, etc.

The queens will carry the larvae in their mandibles, and when a nest is disturbed they may be seen to pick up their brood and hurry off into safety, in the same manner as do the workers, but Hamm has told me that he has actually seen the male perform the same action[64]. Forel has shown that the virgin females in captivity lose their wings in two or three days, removing them themselves, and as females with small gasters are often found in a colony, he suggests that it may be to increase the numbers of the colony, as the workers are not numerous and the females help in the work, and also that they may be fertilized in the nest later on by males produced in it[11]. The female, not being larger than the male, is of course unable to carry him during the marriage-flight.

Many microgynes often occur in colonies of *Leptothorax acervorum*, side by side with ordinary-sized females, and Wasmann records a number of instances of small females, and also intermediate forms between the worker and females, in colonies of this ant in Holland.

In Dutch Limburg he found individuals which represented every gradation in size and shape between the female and worker[22], and he points out that microgynes are much more common than macrogynes[30].

In a colony at Exaeten in July, 1889, he observed a number of

winged females, some with a light yellow-brown thorax, the colour of the worker, and others with the darker coloration of the female, and he records that Dr. Otto Nickerl discovered at Neuhütt in Bohemia a number of light-coloured winged microgynes, which were smaller than the larger workers of the same colony. In August, 1891, in a colony under a stone at Arlberg Wasmann found a number of intermediate winged females, ranging from large dark macrogynes to small light microgynes[30].

He also records a number of forms, intermediate in size, colour, and construction of the thorax, between the female and the worker, taken in a colony at Blijenbeck in September, 1884[30].

On September 14th, 1912, I found in a nest of *Formica rufa* at Weybridge three very large workers of *Leptothorax acervorum*, which were light in colour, but each possessed a large gaster and a somewhat larger thorax than that of the ordinary worker. These are gynaecoid workers, and Butterfield sent me another which he found running on a rock at Rumbold Moor on March 20th, 1918[74]. He also sent me a very curious female taken in a mixed nest of *L. acervorum* and *M. ruginodis* at Mauley Bog, Keighley, on April 26th, 1918[74]. It is a small deälated female, rather dark in colour, and is *exceedingly* remarkable in that it possesses no trace of either a petiole or a post-petiole ! The gaster is joined directly on to the epinotum by the small neck which joins the post-petiole to the gaster in normal females. It measures 3·3 mm. in length. The gaster shows the usual four segments to be seen in ants which possess a two-jointed pedicel. The peculiar construction of this specimen would appear to represent a reversion to an ancestral form[77].

The female of this species is able to found a colony alone ; the small colony in the oak-apple before mentioned was probably an instance of this kind, and I observed a solitary deälated female in a small cavity under a stone at Nethy Bridge on May 19th, 1912[64].

A female may also enter the nest of some other species of ant, as *Leptothorax acervorum* is often found in such situations.

This ant is of a peaceable and gentle disposition, it does not attack other ants of its own, or different species, and it does not appear to be attacked by them. On March 7th, 1910, I collected two small colonies of this species at Weybridge, which were both situated under the bark of fir stumps—as these two stumps were at a considerable distance from each other, the two colonies could not have been connected in any way—and each consisted of a similar number of workers, a deälated female, and some larvae. When introduced into a small, single-chamber plaster nest the two colonies were quite friendly together, and joined forces at once, all the larvae were collected into a heap in one corner of the nest, and both the females rested on them[58]. They were kept under

observation for nine months, during which time they prospered, eggs were laid, and larvae reared. I have written in my note-book on October 30th—" Introduced a dead house-fly into the nest, much excitement noticed, the workers appear to signal to each other by striking the bottom and side of the plaster nest with their gasters."

A number of instances are on record illustrating how frequently *L. acervorum* occurs in the nests of other ants of different species :—

Farren-White found a colony at Shirley inhabiting a gorse stump in the centre of a nest of *Formica sanguinea*[28]; Rothney records specimens in a nest of the same ant in the same locality previous to 1882[20], and in October, 1891, being again at Shirley in quest of nests of *F. sanguinea*, he was indebted, in his success in finding a small colony of that species, entirely to a worker of *L. acervorum*, which by careful watching led him some yards straight to the former's secluded retreat, in which he also found other workers of the latter[24]. Again in 1892 the same observer found specimens of the *Leptothorax* in and about the nest of *sanguinea* at Shirley, more especially in April and May. He writes—" One worker which I watched entered the nest, remained a few seconds, and came out again in no way interfered with by *sanguinea*; but a small nest of *Myrmica scabrinodis*, situated within a foot or two of *sanguinea's*, which I opened up, was smartly attacked, and the workers dispersed. These observations seem to point to some fixed relations between *sanguinea* and *acervorum*."[27].

Burns took the *acervorum* in a nest of *F. fusca* at Bidston Hill, Birkenhead[25], Morice found it in a nest of the same ant at Woodham near Byfleet, Hamm discovered a strong colony in a nest of *F. exsecta* at Bovey Tracey[58], Pool took males, winged females, and workers in a *rufa* nest at Enfield[50], and Hull sent me specimens taken in March, 1912, in a nest of *F. fusca* at West Allendale situated at a height of 1100 ft. Perkins has found it with *A.* (*D.*) *fuliginosus* at Wotton-under-Edge.

Escherich states that *L. acervorum* occurs frequently in the neighbourhood of nests of *F. rufa* and *F. sanguinea* in Germany[51].

Wasmann records it from Holland under bark of fir and oak in connection with *Formica rufa*, *F. pratensis*, *F. sanguinea*, and *F. fusca*, under the bark of an old oak stump with a strong colony of *Acanthomyops fuliginosus*, and in company with *Myrmica ruginodis* under fir bark[23]. He found it at Lippspringe, Westphalia, in July, and in August, 1909, also with *F. truncicola* and *M. laevinodis*, but very rarely with *A. niger* (the *Leptothorax* being nearer the size of the latter); on July 25th he discovered a small colony consisting of males, winged females, and workers, under the bark of a mossy stump in the middle of a nest of *M. ruginodis*; and on August 26th another colony of the *Leptothorax*, containing many queens, in a nest of *F. sanguinea* in a root stump at Hoscheid.

He considers that the "peaceable neighbourhood" with strange ant species is the habitual and original condition of *Leptothorax*[57].

My own captures of this species in other ants' nests are as follows :—

In the nest of *F. rufa* at Weybridge previous to 1902[42]—occasionally with *F. sanguinea* at Woking in 1906[50]—males, winged females, and workers in a nest of *F. rufa* at Nethy Bridge in July, 1908, and continually with *F. rufa* at Weybridge in 1910[58]—a worker in a nest of *F. exsecta*, and a deälated female in a nest of *F. pratensis* at Rannoch on June 12th, 1911, and on a mountain there on June 14th, 1911, two colonies under the same stones as colonies of *M. laevinodis* ; both species had larvae and pupae, and appeared to be quite friendly, they did not attack each other when disturbed, and if they picked up each other's larvae, or pupae, when taking them into safety, they put them down again[61]—males, winged females, and workers under a stone of a *F. rufa* nest in the New Forest on July 22nd, 1912[64], and workers and larvae in a nest of *F. rufa* at Weybridge on September 14th, 1912[65]—a deälated female, workers, larvae and pupae in a nest of *F. sanguinea* at Weybridge on July 12th, 1913, workers in two nests of *F. rufa* v. *alpina* at Rannoch on July 16th, 1913, and a worker in a nest of *F. exsecta* at Parkhurst Forest on August 23rd, 1913[68] ; with *F. rufa* in a gate-post in the New Forest on July 29th, 1918 ; and in a hillock May 10th, 1922 ; with *F. fusca* under stones at Box Hill, April 25th, 1920, and May 4th, 1923 ; with *F. rufa* in the Forest of Dean, June 16th, 1923, and at Abbots' Wood, Eastbourne, September 7th, 1924 ; and with *A.* (*D.*) *brunneus* in Windsor Forest on June 25th, 1925.

On July 12th, 1913, I introduced into my observation-nest of *Formica sanguinea*—which is situated in a "Crawley-Lubbock" nest—a deälated female and a few workers of *Leptothorax acervorum* taken in a *sanguinea* nest at Weybridge. The *acervorum* were not attacked by the *sanguinea* and soon disappeared into the nest. They were not observed again for some time, but during the winter of 1913 they were found to have excavated a small cell in the earth in a corner of the nest, removed from their hosts. They occasionally come out and walk about over the nest, and in the wooden box which contains it, and sometimes visit a small hole in a wooden support on the side of the box. When a *Leptothorax* meets a *Formica*—either *sanguinea*, or *fusca* (slave)—the former stands still and the latter generally runs over it without noticing it, but sometimes just tapping it with the antennae. This tiny colony has lived peaceably in this nest for over nine months.

On June 12th, 1911, I discovered a small colony of *Leptothorax acervorum* situated under the bark of a log lying in a saw-pit, all the ants of which were observed to be covered with a fungus, but

were quite active. The tube in which some of the ants were pl was unfortunately lost, but the fungus was probably a speci *Laboulbeniaceae*[61].

I have taken the Coleopteron *Drusilla canaliculata F.*, in com with *L. acervorum* at Fairlight[38]; and Hallett has found the tacean *Platyarthrus hoffmanseggi* Brndt., with this ant at C yr-ala. Chitty bred the Proctotrupid *Antaeon gracilicollis* F from a nest of this ant taken at Monks' Wood; and the *Cyphodeirus albinos* is sometimes found with it.

The following forms of *Leptothorax* with twelve joints to antennae in the worker and female have been treated by s authorities (Mayr, etc.) as good species, by others as races (F etc.) of *L. tuberum*, or sub-species (Crawley and Donisthorpe, and again by others as varieties (André, etc.) of *L. tuberum* F.

Without expressing any definite opinion on the subject, I p here to treat them as species, as it certainly simplifies matters.

The confusion which has arisen in Britain is chiefly due to fact that *L. unifasciatus* was supposed to occur in this cou but nearly every British specimen recorded under this name be referred to *L. tuberum* F.

Stenamma albipennis Curtis is not distinct from *Leptoth tuberum* F., though Dalla Torre erroneously gives it as a syno of *L. nylanderi* Först.—Curtis describes his *albipennis* as ha the club of the antennae in the worker fuscous, this proves his insect was not *nylanderi*—Nylander sinks *albipennis* Curtis synonym of *unifasciatus* Ltr., and F. Smith recorded *L. unifasc* from Dover on the strength of specimens in Curtis's Colle (these were obviously the Dover specimens described by Curt *albipennis*).

It is evident that both Curtis and F. Smith were aware considerable confusion existed with regard to the names of British species of this group, as the former wrote of *L. tuber* "This species requires investigation," and the latter wri "The *unifasciata* of British collections is not that which contin Hymenopterists consider to be Latreille's species; in one re it does not quite agree: the female has, in fact, three bands o abdomen, and the worker has the abdomen nearly entirely fus only the base and apex pale; it cannot be said to have 'une b noire transverse sur le bord postérieure du premier segment but neither Curtis, Smith, Farren-White, nor Saunders made attempt to rectify matters.

Saunders determined various specimens as *unifasciatus*, b was never able to make these agree with Forel's tables, nor descriptions of that species, and this led to my arranging in for the loan of all the specimens standing under the name of *fasciatus* in the British, Oxford, and Cambridge Museums; t

included the Saunders, Dale, Rothney, and Perkins collections, etc. Crawley and myself took these and others to Dr. Forel on our visits to him, and he determined nearly all these examples (undoubtedly correctly) as *L. tuberum* F., *sensu stricto*.

In 1914 Crawley published a revision of the British species of *Leptothorax*, which has added much to our knowledge of this genus. We appear to possess *L. tuberum* F., *L. nylanderi* Förster, *L. interruptus* Schenck, and *L. corticalis* Schenck, but the inclusion of *unifasciatus* in our list requires confirmation as Crawley and I have seen every specimen captured here, with the exception of those in the Curtis Collection (now in Melbourne Museum), and have been unable to detect *unifasciatus* among them.

Two workers, taken at Hayling Island in 1883, were presented by Saunders to the Oxford Museum as *unifasciatus* ; these are determined by Forel as *affinis*, all the other specimens taken by Saunders on Hayling Island are certainly *tuberum*. The specimens taken in 1883 were recorded by Saunders as occurring under a stone at Hayling, and in 1896 he speaks of large nests of *unifasciatus* also under stones at South Hayling, whereas Mayr, Forel, and André all record *affinis* as occurring on tree trunks and under bark. I took it at Yvorne in Switzerland in 1912 in a hollow walnut stick ; Dr. Forel told me this is its usual habitat there. It would seem that the two specimens examined by Forel are more probably abnormal forms of *tuberum* rather than specimens of *affinis*, a species not actually known to occur in this country, and more material should be collected and examined before we can admit *L. affinis* Mayr to our list.

Leptothorax nylanderi Först.

Myrmica nylanderi Förster Hym. Stud. **1** 53 (1850)[1] ; Schenck Jahr. Ver. Naturk. Nassau **8** 135 (1852)[2]. *Myrmica cingulata* Schenck Jahr. Ver. Naturk. Nassau **8** 104–106 144 (1852)[3]. *Myrmica tuberum* Curtis Trans. Linn. Soc. Lond. **21** 216 (1854)[4]. *Leptothorax nylanderi* Mayr Verh. Zool. Bot. Ver. Wein **5** 447–448 (1855)[5]. *Myrmica (Leptothorax) cingulata* Nylander Ann. Sc. Nat. Zool. (4) **5** 93 (1856)[6]. *Myrmica (Leptothorax) nylanderi* F. Smith Cat. Brit. Foss. Hym. 30 (1858)[7] : Trans. Ent. Soc. Lond. (n.s.) **4** 1857 280 (1858)[8]. *Leptothorax nylanderi* F. Smith Ent. Ann. **1868** 94[9]. *Leptothorax tuberum* r. *nylanderi* Forel Denkschr. Schweiz. Ges. Naturw. **26** 84[10] 340[11] 416[12] (1874). *Leptothorax nylanderi* Parfitt Trans. Devon Assn. Sc.-Art. **12** 516–517 (1880)[13] ; Saunders Trans. Ent. Soc. Lond. **1880** 219–220[14] : Ent. Mo. Mag. **17** 69 (1880)[15]. *Leptothorax tuberum* F. v. *nylanderi* Er. André Spec. Hym. Europe **2** 300 (1881)[16]. *Leptothorax nylanderi* Rothney Ent. Mo. Mag. **18** 262 (1882)[17] ; Saunders Ent. Mo. Mag. **20** 19 (1883)[18] ; Dalla Torre Cat. Hym. **7** 125 (1893)[19] ; Farren-White Ants' Ways 244 (1895)[20] ; Morley Ent. Rec. **6** 114 (1895)[21]. *Leptothorax tuberum* F. race *nylanderi* Saunders Hym.-Acul. 38 (1896)[22] ; Morley Hym. Suffolk **2** 2 (1899)[23]. *Leptothorax nylanderi* Donisthorpe Ent. Rec. **14** 16 (1902)[24] : Trans. Leicester Lit.-Phil. Soc. **12** 227 (1908)[25] : Ent. Rec. **20** 282 (1908[26]) ; Baynes Ent. Rec. **23** 98 (1911)[27] ; *Leptothorax tuberum* F., subsp. *nylanderi* Donisthorpe Entom. **44** 390 (1911)[28]. *Leptothorax nylanderi* Donisthorpe Ent. Rec. **26**

39 (1914)[29]. *Leptothorax tuberum* F. subsp. *nylanderi* Crawley Ent. Rec. **26** 92, 95, 107 (1914)[30]. *Leptothorax* (*Leptothorax*) *nylanderi* Emery Bull. Soc. Ent. Italiana **47** 175 (1916)[31]. *Leptothorax nylanderi* Donisthorpe Ent. Rec. **28** 2 (1916)[32]; Box Ent. Mo. Mag. **53** 17 (1917)[33]; Donisthorpe Ent. Rec. **30** 22 (1918)[34]. *Leptothorax* (*Leptothorax*) *nylanderi* Emery Gen. Ins. **174** 255 (1922)[35]. *Leptothorax nylanderi* Donisthorpe Ent. Rec. **36** 50[36] 122[37] (1924).

☿ *Yellow, head above often reddish brown, gaster with a broad brown band on the first segment, and sometimes with narrow bands on the succeeding ones. The whole of the antennae, mandibles, and legs yellow.*

Head finely longitudinally striate ; *clypeus* as in *tuberum* ; *antennae* twelve-jointed. *Thorax* finely rugose, with a distinct impression between the mesonotum and epinotum ; *epinotal spines* broad at the base, as long as two-thirds of the basal surface of the epinotum. *Pedicel* finely rugose, *gaster* smooth and shining. *Legs* without erect hairs. *Long.* 2·3–3·5 mm.

♀ *Yellow, head red to reddish brown, thorax mostly yellow, with two brown patches at the insertion of the wings, and a brown patch at the base of the scutellum, pedicel brownish, gaster yellow with a broad blackish brown band at the base of the first segment, and narrow bands at the base of the other segments ; mandibles, clypeus, the whole of the antennae and legs yellow.*

Head longitudinally striate ; *clypeus* as in *tuberum* ; *antennae* twelve-jointed. *Thorax* : *mesonotum* longitudinally striate, but not so coarsely as in *tuberum* ; *scutellum* smooth and shining in the centre ; *epinotal spines* long, one-third as long as the basal face of the epinotum. *Petiole* and *post-petiole* more finely striate than in *tuberum* ; *gaster* smooth and shining. *Wings* clear, radial cell small, closed. *Long.* 4·2–4·7 mm.

Fig. 77. Pedicel of *Leptothorax nylanderi* ♂.

♂ *Blackish brown, the clypeus, and sometimes the rest of the thorax, reddish brown, mandibles, antennae, legs and extremity of gaster pale dirty yellow.* On the whole a little more robust than the male of *tuberum.*

Head a little more finely rugose than in *tuberum* ; *mandibles* with four to five teeth* ; *antennae* with joints as in *tuberum. Thorax* much less rugose than in *tuberum* ; *mesonotum* smooth and shining between the Mayrian furrows, the rest of the thorax is shining and smooth with the exception of some fine striae ; *epinotum* without, or with only very faint tubercles. *Pedicel* smooth and shining ; *petiole* viewed in profile raised in centre, higher and less strongly rounded than in *tuberum* ; *post-petiole* about as high as long ; *gaster* smooth and shining. *Wings* as in the ♀. *Long.* 3–3·2 mm. (2·5–3·2 mm. *teste Forel.*)

Original description of *Myrmica nylanderi* Förster [Hym. Stud. **1** 53 (1850)] :—

" **Mas** : Fusco-nigricans, laevis ; capite et metathorace subtilissime rugulosis ; mandibulis et clypeo rufis ; palpis, antennis 13–articulatis pedibusque flavis ; metathorace inermi, alis albo-hyalinis, area radiali aperta. *Long.* $1\frac{1}{3}$ lin.

Die Färbung dieser Art ist ein mehr oder weniger dunkles Braun, der

* Five-toothed in the specimens before me.

Kopf und Hinterleib geht mehr in's Schwärzliche. Der erstre erscheint fein runzlig, zwischen der Fühlerwurzel vom Clypeus bis zu den Nebenaugen hinauf mit feinen Längsstreifen. Der Clypeus und die Mandibeln sind roth, diese klein, mit 5 Zähnen, vor der Basis deutlich eingeschnürt, an der Spitze nur mässig erweitert, jener mit schwachen Längsrunzeln, übrigens glatt; ein Stirnfeld nicht deutlich abgesetzt. Die Fühler 13-gliedrig, der Schaft kurz, kaum die Länge der drei folgenden Glieder zusammen genommen übersteigend an der Geissel das 1–7te Glied ungefähr von gleicher Dicke, das 1, 4, 6, 7te unter sich gleich, aber ein wenig länger als das 2te 3, 5te, welche unter sich an Länge ebenfalls übereinstimmen; die 4 letzten Glieder bilden eine schwache Keule, deren Glieder allmählig an Grösse etwas wachsen, das letzte Glied ist aber völlig so lang und fast etwas länger als die beiden vorhergehenden zusammen genommen. Fühler wie Taster blassgelb, die Nebenaugen sehr gross. Der Kopf in Allgemeinen sehr klein und hinter den stark vortretenden Netzaugen merklich eingeschnürt. Der Mittelleib pechbraun, nicht so dunkel gefärbt wie der Kopf, der Hals etwas röthlich. Von den 3 Lappen des Mesonotum's ist der mittlere fast ganz, die seitlichen aber nach vorne glatt, die Furchen convergiren in der Mitte des Mesonotum's, stossen aber nicht ganz zusammen und von hier aus bis zu dem Schildehen ist dieser Theil des Mittelbrustrückens etwas flach gedrückt und fein längsstreifig-runzlig. Die Mesopleurae und das Mesosternum völlig glatt und stark glänzend. Der Metathorax fein runzlig, unbewehrt, die abschüssige Stelle nur unmittelbar über der Anheftungsstelle des Hinterleibs ein wenig glatt. Die Flügel glashell, mit ganz blassen, unscheinbaren Adern, und eben so gefärbtem Stigma, die Radialzelle sehr schmal, nicht ganz geschlossen, die 1ste Diskoidalzelle ebenfalls nicht augebildet. Die Beine sehr dünn, ganz blassgelb und genau so gefärbt wie die Fühler. Die Schenkel schwach gebogen, das 1ste Fussglied länger als die 4 folgenden zusammen genommen, an dem vordersten Fusspaar aber an der Basis nur wenig gebogen und dabei etwas verdickt. Der Hinterleib tief schwarzbraun, die Knoten des 1sten Segments glatt, in den Seiten und am Hinterrande fein runzlig, an dem ersten Knoten die vordere sanft abschüssige Seite fast doppelt so lang als die hintere, mehr steil abfallende; die untere Seite nach der Basis hin in eine sehr feine aber auch sehr kurze Spitze ausgezogen. Auch der hintere Knoten zeigt, von der Seite betrachtet, einen stumpfen, wenig in die Augen fallenden Vorsprung Die Spitze des Hinterleibs vom 4ten Segment ab, sowhol auf der Rückenwie auf der Bauchseite röthlichgelb. Der ganze Körper ist mit zerstreuten, ziemlich langen, feinen Härchen besetzt, welche am Hinterrand der Segmente und namentlich an der Spitze des Hinterleibs so wie auf der Bauchseite etwas gedrängter zusammenstehen und daher leichter in die Augen fallen."

Habitat.

L. nylanderi is found in Central and Southern Europe, in the Caucasus, but is less widely distributed in the north.

Its distribution in Britain is as follows :—

Devon, S. : Stoke and Exeter (*Parfitt*)[13]; Bovey (*Perkins*).

Isle of Wight : Ryde (*Donisthorpe*)[26].

Hants, S. : Dibden (*Crawley*).

Sussex, W. : Bosham (*Harwood*).

Kent, W. : Lee, Blackheath (*Farren-White*)[20]; Bromley (*Saunders*)[22].

Surrey : Chobham and Wimbledon (*Saunders*)[14]; Shirley (*Rothney*)[17]; Esher and Woking (*Champion*); Claygate, Mickleham and Addington Park (*Power*); Brixton[4] and Camberwell (*Wing*);

Richmond Park[25], Oxshott[24], and Box Hill[29] (*Donisthorpe*); South Norwood (*Rothney Coll.*).

Essex, S.: Billericay (*Box*)[33]; **Essex, N.:** Ardleigh and Colchester (*Harwood*).

Berks: Wellington College[25], Padworth[36], and Windsor Forest[37] (*Donisthorpe*); Pangbourne (*Ryle*); near Cookham (*Baynes*)[27].

Bucks: Burnham (*Harwood*).

Suffolk, E.: Ipswich (*Morley*)[21]; Little and Great Blakenham, Bentley Woods, Dodnash Woods, Tattingstone, and Whersted (*Morley*)[23]; **Suffolk, W.:** Bures (*Harwood*)[22]; Tostock (*Tuck*)[23]; Nayland (*Harwood*).

Gloucester, W.: Near Stonehouse (*Davis*); Bristol (*Bacchus*).

Monmouth: Chepstow Castle (*Hallett*).

Salop: Shrewsbury (*Hodson*).

Leptothorax nylanderi prefers to dwell in shady places in woods and coppices, where it chiefly nests in wood, and under bark, in which it excavates small galleries, and it will sometimes appropriate the old borings of other insects. Schenck[3] says it occurs in moss on trees and rocks, and Mayr[5] also mentions that it sometimes nests in moss. It may be found in fallen boughs, and at the foot of old tree trunks, but it never occurs under stones.

Saunders took solitary workers by sweeping at Chobham and Wimbledon[14], Morley records it as occurring on *Linaria vulgaris* (Yellow Toad-Flax) in the summer near Ipswich[23], and Harwood swept up workers in the saltings at Bosham, near Chichester, in August, 1920.

Curtis records that Wing found it under oak bark at Brixton in April[4], and there are specimens in the late Frederick Smith's collection taken under bark at Camberwell in March, 1852. I am inclined to think the latter are from the same source, as a specimen in the British Museum labelled "Camberwell" was also taken by Wing.

Farren-White found a small colony consisting of nine queens and sixteen workers in an old stump at Lee near Blackheath on September 9th, 1861[20], Harwood found nests at Bures under poplar bark[22], Morley took a specimen under the bark of a dead willow at Ipswich on February 13th, 1894[21], and he says it is common in the winter beneath aspen and maple bark in that district[23]. In October, 1914, I visited Morley's locality near Claydon and found five or more colonies under bark of poplar. These colonies, of about fifty workers and one queen in each, were situated under small bits of very close-fitting bark.

Parfitt found a colony in August, 1864, in a hollow stick near Exeter[13], and I discovered a strong colony, situated in a fallen bough in Richmond Park[25] in June, 1907, which contained one deälated female and a number of workers and brood.

Bacchus found a colony in a decayed branch at Sea Mills, Bristol, in April, 1922, and Ryle another inhabiting a larch stump at Pangbourne in April, 1923.

Parfitt records another colony which occurred in a lane leading from Marypole Head, Exeter, to Cowley Bridge, in an old oak stump which had been bored into by some beetle, probably an *Anobium*, and in whose holes the ants had their runs, their nest being in a larger hole[13].

I found specimens occupying the burrows of a beetle, *Priobium castaneum*, in a broken bough on an old ash at Ryde, Isle of Wight[26], on October 23rd, 1908, and a large colony at Padworth on August 31st, 1923, nesting in the burrows of the same beetle in an old holly tree in a hedge[36]. Baynes discovered a small colony tenanting an old disused burrow of the "Clear-Wing," *Sesia andrenaeformis*, in a twig of *Viburnum lantana* near Cookham in Berkshire on June 28th, 1911[27]. Box records finding a colony of *F. nylanderi* nesting in the base of a post at Billericay, Essex, on October 8th, 1916. The ants were utilizing the burrows of *Ptilinus pectinicornis* for their nest, having increased the size by tunnels evidently of their own make[33].

Leptothorax nylanderi has also occurred in the nests of other ants —F. Smith wrote in 1868 :—"The *Leptothorax nylanderi* has never been found in any other situation than in ants' nests, usually those of *Formica rufa*."[9] He does not give any references, I am not aware of any records of this ant being found in *rufa* nests, and I think he must have had some other species, probably *Formicoxenus nitidulus*, in his mind.

There are, however, records of the occurrence of *L. nylanderi* with species other than *F. rufa*—Rothney captured a few specimens in a nest of *F. sanguinea* at Shirley, in 1867[17], and in his collection, now at Oxford, there are specimens taken with *Acanthomyops fuliginosus* at South Norwood, and by Dr. Power with the same ant at Claygate on May 12th, 1867.

Saunders found it on Whit Monday, 1883, in company with *A. fuliginosus* on a bank at Chobham[18], I took both deälated females and workers in a nest of the same ant at Oxshott[24] in March, April, and May, 1896 and 1897, workers at Wellington College[25] in April and May, 1906, and on September 7th, 1913, a deälated female in a nest of *A. mixtus* in a tree root at Box Hill[29]. In 1924 I not infrequently found little colonies of *L. nylanderi* inhabiting the same trees in Windsor Forest in which *A.* (*D.*) *brunneus* was present.

Their nests consisted of little cells in and under the bark, and these tiny ants were sometimes walking freely about in the runs of the larger species[37].

According to Mayr, *L. nylanderi* swarms in midsummer[5], Schenck took the winged forms in the nest on August 21st, and in grass

on September 25th and October 15th at Nassau[3], and Forel found males in abundance in nests at Vaux in September, 1867[12]. Champion caught winged females by sweeping at Esher on September 20th, 1874, and Morley obtained all three castes beneath poplar bark at Tattingstone in October, 1899[23]. On October 10th, 1914, I found two males in a colony under poplar bark near Ipswich.

Box found numerous winged females and one male in the nest at Billericay on October 8th, 1916.

Forel kept a colony of this species in captivity in April, 1868, which consisted of a deälated female and sixty workers, and many larvae were brought up from the queen's eggs, but he found they would not rear strange larvae. The workers would sometimes devour insects given to them, and males and workers were produced, the former appearing on June 29th and during July[11].

On October 9th and 10th, 1912, I found two colonies of *Leptothorax* at Yvorne, Switzerland, each being situated in a hollow walnut stick, the one being *L. affinis*, the other *L. nylanderi*. I brought both sticks home and introduced their contents into a four-chambered "Janet" nest. Each colony consisted of a deälated female, workers and larvae, but males were also present in the stick belonging to the *affinis*. The two species joined forces, without any fighting, all the larvae were collected into one heap and both females rested on it, eggs were laid and the ants all lived together in amity. The *affinis* queen died on January 21st, 1913, but the *nylanderi* queen and a number of workers—which are, however, nearly all *nylanderi*—and larvae were still under observation (March, 1914). Workers may often be seen to carry their fellows, when the one that is carried is held by the jaws with the dorsal surface uppermost, above the body of the carrier. Two *nylanderi* queens, workers, and brood, obtained near Ipswich in October, 1914, were introduced into this *affinis–nylanderi* nest. Some fighting took place at first, but no deaths occurred ; the bulk of the new ants remaining by themselves in one chamber of the nest. After three months they were found to have amalgamated with the old inhabitants, and become one colony. In 1915 two males were developed in this nest, the first appeared on July 14th and the second on July 25th. On July 30th worker pupae of *Myrmica scabrinodis* were given to these ants to act as food ; some were eaten, but a few were allowed to hatch ; all of them with the exception of one worker were then dragged about, and they died in a few days. This one *Myrmica* worker, however, was not molested, and it lived in the nest until November 3rd, when it died, apparently a natural death. It was a very curious sight to see the enormous *Myrmica* worker, in comparison with the little *Leptothorax* workers, quite at home in their nest, walking about and resting with them

on their brood. By the end of 1915 all the *L. affinis* in the nest appeared to have died off. In 1917 winged females as well as males were developed in this colony as follows :—March 18th male and female pupae present ; May 24th—first male appeared ; June 1st—three winged females and seven males ; June 6th—fourteen winged females and twenty-eight males ; June 9th—a few of the females had started to shed their wings ; June 17th—over thirty winged females, and over fifty males present. June 21st—the winged sexes were evidently desirous of taking their marriage-flight, hurrying about all over the nest, and on the glass roof, and trying to fly as well as they could in the confined space. The workers were also very excited and running about in every direction ; only the old queen remained quietly resting on the larvae and pupae. Similar attempts at a marriage-flight were observed on June 28th, July 2nd, 10th, 12th and 14th. June 23rd—winged females were seen to help carry about the larvae. June 27th—a gynandromorphous pupa was noticed, the head and thorax appeared to be chiefly female and the gaster male. The workers took considerable interest in it, two or three generally sitting round it and tapping it with their antennae. July 10th—it was dead and the workers had bitten holes in it ; July 29th—only a few males and winged females still present ; August 19th—all the males were dead, and the females had removed their wings ; December 31st—very many medium and small larvae were present on the floor of the second dark damp chamber, and hung on the walls by their anchor-tipped hairs ; numbers of workers present and the old queen, but very few of the new deälated females had survived[34]. This colony eventually perished in 1921, as the nest was allowed to get dry during my absence from home. The old queen died on November 1st, 1920.

In 1906 I took a large worker (3·5 mm. in length) of *Leptothorax nylanderi* in a nest of *Acanthomyops fuliginosus* at Wellington College which has the head more rounded than in the ordinary worker, the gaster longer, and banded as in the female ; evidently a similar intermediate form to those before mentioned under *L. acervorum.*

Leptothorax corticalis Schen.

Myrmica corticalis Schenck Jahrb. Ver. Naturk. Nassau **8** 100 (1852)[1]. *Leptothorax corticalis* Mayr Verh. Zool. Bot. Ver. Wien **5** 440 (1855)[2]. *Myrmica* (*Leptothorax*) *corticalis* Schenck Jahrb. Ver. Naturk. Nassau **16** 197 (1861) ♂[3]. *Leptothorax tuberum* r. *corticalis* Forel Denkschr. Schweiz. Ges. Naturw. **26** 85[4] 227[5] (1874). *Leptothorax tuberum* var. *corticalis* Er. André Spec. Hym. Europe **2** 298 (1881)[6]. *Leptothorax corticalis* Dalla Torre Cat. Hym. **7** 123 (1893)[7]. *Leptothorax tuberum* Vic. Hist. Berks **1** 76 (1906)[8]. *Leptothorax tuberum* subsp. *corticalis* Crawley Ent. Rec. **24** 63 (1912)[9] ; Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 19 (1913)[10] ; Crawley Ent. Rec. **26** 92, 95, 106 (1914)[11] ; Emery Bull. Soc. Ent. Italiana **47** 175 (1916)[12]. *Leptothorax* (*Leptothorax*) *corticalis* Emery Gen. Ins. **174** 253 (1922)[13].

☿ *Reddish brown, mandibles, antennae, articulations of the legs, and tarsi reddish yellow, femora and tibiae red-brown, head above and first segment of the gaster dark brown. The colour is sometimes lighter as in a specimen before me from Munich.*

Head finely striate ; *clypeus* as in *tuberum ; antennae* twelve-jointed. *Thorax* finely striate, but more rugose than in *nylanderi*, without a distinct impression between the mesonotum and epinotum ; *epinotal spines* very broad at base, horizontal, very short, scarcely as long as a third of the basal face of the epinotum. *Pedicel* finely striate ; *gaster* smooth and shining. *Legs* without erect hairs. *Long.* 2·5–3·2 mm.

♀ *Dark brown, mandibles, antennae and legs yellow-red.*

Head longitudinally striate ; *clypeus* as in *tuberum ; antennae* twelve-jointed, *club* no darker than the rest of antennae. *Thorax : mesonotum* and *scutellum* finely striate longitudinally ; *epinotal spines* short. *Pedicel* finely striate ; *gaster* smooth and shining. *Long.* 3·5–4 mm.

♂ I have not seen a typical male ; Schenck's description will be found below, and Crawley describes a male in the British Museum collection from Naples labelled " *corticalis* var." as follows :—

" Joints 2–5 of funiculus much longer than broad. Head rugose ; mesonotum smooth and shining between the converging lines ; pedicel slightly rugose, and shaped as in *nylanderi ;* gaster smooth and shining ; epinotum with slight tooth-like tubercles. Too faded to judge of colour."[11]

This specimen, however, according to Emery, is simply a pale variety of *L. tuberum* F. It was sent to him by F. Smith many years ago.

Original description of *Myrmica corticalis* Schenck [Jahrb. Ver. Naturk. Nassau **8** 100 (1852)] :—

" A. 1⅓ bis 1½ L. *Mittelleib und Stiel braunroth, Oberseite des Kopfes und der ganze Hinterleib oben und unten schwarzbraun*, letzterer stark glänzend. Oberkiefer, Fühler, Backen, Unterseite des Kopfes sowie die Beine braunroth ; *die Fuhlerkeule braunroth, die Schenkel bräunlich,* oft auch die Knoten. Der ganze Körper mit zerstreuten gelblichen Borstenhärchen besetzt. *Die Fühler* 12 *gliedrig,* das erste Geisselglied verdickt und verlängert, die folgenden sehr verkürzt, das achte etwas länger, das neunte und zehnte noch mehr verlängert und verdickt, das letzte am dicksten und so lang, als die drei vorhergehenden, die vier letzten bilden eine Keule. Der Kopf ist fein längstreifig ; der Thorax zeigt unter der Lupe schwache unregelmässige Längsstreifen ; der Metathorax hat *zwei sehr kurze breite dreieckige wagrechte Dornspitzen* ; auf jeder Seite das Metathorax zieht sich über und unter demselben ein brauner Rand. Die Knoten sind längsrunzelig, der Hinterleib kurz rundlich. *Die Beine sind kahl.* Von den A. der zwei vorigen Arten durch die rothe Fühlerkeule, den ganz schwarzbraunen Hinterleib, die kahlen Beine, die kurzen Dornspitzen und die 12 gliedrigen Fühler verschieden.

W. (nur im ungeflügelten Zustande mir bekannt). Fast 2 L. *Schwarzbraun,* Thorax und Hinterleib glänzend. Oberkiefer, Fühler nebst Keule, Beine braunroth, *die Schenkel braunlich.* Der Kopf längsgestreift, der Kopfschild mit groben Streifen, deren mittelster sich kielartig erhebt. Der Thorax ist oben breit und flach, Mesothorax und Schildchen fein längsstreifig. Der Metathorax hat *zwei kurze, fast wagrechte Dornspitzen.* Die Knoten sind längsrunzelig, der Hinterleib breit, kurz, rundlich."

Description of the male of *Myrmica* (*Leptothorax*) *corticalis* Schenck [Jahrb. Ver. Naturk. Nassau **16** 197 (1861)] :—

" ♂ Sehr ähnlich *interrupta*, glänzend schwarz, Fühler 13 gliedrig, Geisselglied 2 sehr kurz, Schaft viel länger, ohnegefähr so lang als Glied 4 und 5 zusammen, aber viel kürzer, als die halbe Geissel ; Fühler hellbraun mit hellerem Endglied, Beine hellbraun ; Thorax glatt, ohne Längsstreifen, sehr glänzend ; Flügel wasserhell, etwas ins Milchweisse fällend."

A single worker of a *Leptothorax* from Stoke Fleming or Slapton, taken by Perkins, is said by Forel to be " nearly *corticalis*." It has the antennal club no darker, the short broad spines and coloration of typical *corticalis*, and Crawley states that he has little doubt that it is *corticalis*[11].

(There are also a number of workers in the Cambridge Museum without data except " Perkins Coll.," called by Forel " *tuberum* with spines almost *corticalis*." The spines are very short but the antennal club is dark brown, and in other respects the ants are exactly similar to *tuberum*, and I agree with Crawley that they are only a short-spined variety of *tuberum* F.)

On April 24th, 1904, Crawley found in a wood at Buckhold Hill, near Pangbourne, Berks, a fallen beech-nut, perforated with a small hole, probably by some insect, which contained an incipient colony of a *Leptothorax*, consisting of a deälated female, one worker, and two half-grown larvae[9]. These were named by Forel " *corticalis* var. with longer spines," and Crawley describes the female and worker as follows[11] :—

" ☿ Thorax finely rugose, less than in *nylanderi*. Spines very broad at base, long, about two-thirds as long as the basal face of epinotum. Reddish yellow ; mandibles, whole of antennae, and legs of the same colour ; top of head dark brown ; whole of gaster as seen from above, except a small patch on the front of the first segment, black-brown. L. 2·3 mm."

" ♀ Mesonotum finely striated longitudinally. Middle of scutellum smooth and shining. Spines long, about one-third as long as basal face of epinotum. Antennae, mandibles, mesonotum, legs, and front of first segment of gaster entirely reddish yellow ; head, scutellum, and remainder of gaster, dark brown. L. 3·7 mm."

L. corticalis appears to be rare in the Centre and South of Europe, and lives entirely under the bark of trees, sometimes constructing small galleries in the bark.

Leptothorax tuberum F.

Formica tuberum Fabricius Syst. Ent. 393 (1775)[1] ; Latreille Ess. Hist. Fourmis France 47 (1798)[2]. *Formica tuberosa* Latreille Hist. Nat. Fourmis 259 (1802)[3]. *Myrmica tuberosa* Latreille Hist. Nat. Crust. Insect. **13** 259 (1805)[4]. *Manica tuberum* Jurine Nouv. Méth. Class. Hym. 279 (1807)[5]. *Myrmica unifasciata* Shuckard Mag. NH. (n.s.) **2** 626 (1838)[6]. *Myrmica tuberum* Nylander Acta. Soc. Sc. Fenn. **2** 939 1057 (1846)[7]. *Myrmica unifasciata* Curtis Trans. Linn. Soc. Lond. **21** 216 (1854)[8]. *Stenamma albipennis*

Curtis Trans. Linn. Soc. Lond. **21** 218 (1854)[9]. *Leptothorax tuberum* Mayr Verh. Zool. Bot. Ver. Wien **5** 442 (1855)[10]. *Myrmica unifasciata* F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 128–129 (1855)[11]. *Stenamma albipennis* F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 134 (1855)[12]. *Myrmica unifasciata* F. Smith Ent. Ann. **1858** 39[13] : **1862** 70[14]. *Leptothorax unifasciata* F. Smith Ent. Mo. Mag. **2** 29 (1865)[15]. *Myrmica unifasciata* F. Smith Ent. Ann. **1868** 92[16]. *Leptothorax tuberum* Forel Denkschr. Schweiz. Ges. Naturw. **26** 85[17] 227[18] 415[19] (1874). *Leptothorax unifasciata* Saunders Trans. Ent. Soc. Lond. **1880** 220[20]. *Leptothorax tuberum* Er. André Spec. Hym. Europe **2** 298 (1881)[21]. *Leptothorax unifasciata* Dale Ent. Mo. Mag. **17** 236 (1881))[22] ; Saunders Ent. Mo. Mag. **20** 87 (1883)[23]. *Leptothorax tuberum* Adlerz Bih. Sv. Vet. Acad. Handl. **11** 82 (1886)[24] ; Fletcher Ent. Mo. Mag. **25** 313–314 (1889)[25]. *Leptothorax tuberum tuberum* Bruyant Fourmis France centr. 58 (1890)[26]. *Leptothorax unifasciata* Perkins Ent. Mo. Mag. **27** 195 (1891)[27]. *Leptothorax tuberum* Dalla Torre Cat. Hym. **7** 127 (1893)[28]. *Leptothorax unifasciata* Farren-White Ants' Ways 244–245 (1895)[29]. *Leptothorax unifasciatus* Saunders Hym.-Acul. 38 (1896)[30]. *Leptothorax tuberum* Vic. Hist. Worcester **1** 87 (1901)[31]. *Leptothorax tuberum* F. race *unifasciata* Vic. Hist. Sussex **1** 131 (1905)[32] ; Nevinson Ent. Mo. Mag. **41** 22 (1905)[33]. *Leptothorax tuberum* Vic. Hist. Cornwall **1** 182 (1906)[34]. *Leptothorax unifasciatus* (teste Saunders) Donisthorpe Ent. Rec. **19** 254 (1907)[35] : Trans. Leicester Lit.-Phil. Soc. **12** 227 (1908)[36]. *Leptothorax tuberum* F. subsp. *unifasciata* Donisthorpe Entom. **44** 390 (1911)[37]. *Leptothorax unifasciata* Donisthorpe Ent. Rec. **24** 5 (1912)[38]. *Leptothorax tuberum* Donisthorpe Ent. Rec. **24** 306 (1912)[39]. *Leptothorax tuberum* subsp. *tuberum* Crawley Ent. Rec. **26** 93, 96, 108 (1914)[40]. *Leptothorax* (*Leptothorax*) *tuberum* Emery Bull. Soc. Ent. Italiana **47** 174 (1916)[41]. *Leptothorax tuberum* Donisthorpe Ent. Rec. **31** 1 (1919)[42]. *Leptothorax* (*Leptothorax*) *tuberum* Emery Gen. Ins. **174** 256 (1922)[43].

☿ *Yellow, or slightly reddish yellow, the head above anteriorly, sometimes the vertex, and the club of antennae blackish brown. Gaster with an irregular brown patch across the base of the first segment and extending up each side. The legs and the rest of the antennae yellow.*

Head longitudinally striate, and finely rugose ; *clypeus* convex, with a small median ridge, and two or more lateral striae ; *antennae* twelve-jointed. *Thorax* finely rugose, dorsal surface not interrupted between the mesonotum and epinotum ; *epinotal spines* variable in length, narrow at the base, about half as long as the basal face of the epinotum. *Pedicel* finely rugose ; *gaster* smooth and shining. *Legs* without erect hairs. *Long.* 2·3–3 mm.

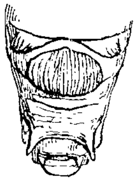


Fig. 78. Scutellum and epinotum of *Leptothorax tuberum* ♀.

♀ *Dark brown, or reddish brown, club of antennae blackish brown, the rest of the antennae, mandibles, legs, and often a broad patch on the anterior border of the first and second segments of the gaster yellow.*

Head more strongly longitudinally striate than in the ☿ ; *clypeus* as in the ☿ ; *antennae* twelve-jointed. *Thorax* : *mesonotum* and *scutellum* longi-

tudinally striate ; *epinotal spines* medium in length, not so long as in *nylanderi*. *Petiole* and *post-petiole* finely striate ; *gaster* smooth and shining. *Wings* clear ; *radial cell* small and closed. *Long.* 3·7–4·5 mm.

Fig. 79. Pedicel of *Leptothorax tuberum* ♂.

♂ *Brownish black, mandibles, antennae, legs, and extremity of gaster, dirty pale yellow.*

Head finely rugose ; *mandibles* with terminal border quadridentate ; *antennae* thirteen-jointed, with a narrow, but distinct, four-jointed *club*, *scape* much longer than the second joint of funiculus, *funiculus* with joints two to five twice as long as broad. *Thorax: mesonotum* rugose ; *scutellum* smooth and shining ; *epinotum* rugose, armed with two blunt tooth-like tubercles. *Pedicel* finely rugose ; *petiole* viewed in profile slightly raised and rounded in the centre ; *post-petiole* somewhat longer than high ; *gaster* smooth and shining. *Wings* as in the ♀. *Long.* 2·5–3·2 mm.

Original description of *Formica tuberum* Fabricius [Syst. Ent. 393 (1775)] :—

" F. rufa, capite abdominisque fascia nigris, petiolo binodi. Habitat in Suecia.

Praecedente minor. Antennae rufae, apice nigrae. Thorax ferrugineus, postice bidentatus."

Habitat.

L. tuberum ranges over Europe in the centre and south and in the Caucasus, but is less widely distributed in the north.

In Britain it is found in the following counties :—

Cornwall : Cornwall[34].

Devon, S. : Seaton (*Dale*)[22]; Stoke Fleming (*Perkins*)[27]; Torquay (*Hamm*)[36].

Dorset : Portland[22], Lulworth[22], and " Burning Cliff " near Weymouth (*Dale*)[29]; Lyme Regis (*Nevinson*)[33]; Ringstead (*Haines*).

Isle of Wight : Landslip (*Lewis*)[14]; Ventnor (*Saunders*)[20].

Hants, S. : Hayling Island (*Saunders*)[32]; New Forest (*Dale*)[11].

Sussex, E. : Fairlight near Hastings[32].

Kent, E. : Near Dover (*Curtis*)[9]; St. Margaret's Bay (*Donisthorpe*)[35]; **Kent, W. :** Lower Shorne near Gravesend (*Baly*)[13].

Surrey : Coombe Wood (*F. Smith*)[8].

Essex, S. : Southend (*Saunders's Coll.*).

Middlesex : Colney Hatch (*F. Smith*)[11].

Gloucester, W. : Gully Durdham Down (*Bacchus*).

Worcester : Worcester (*Fletcher*)[25]; sides of the Teme, Powick, Bransford[31].

Leptothorax tuberum is found in moss, decaying wood, in and under bark, in old stumps, in the dry stems of brambles, and also under stones.

Latreille recorded it as inhabiting the chinks in walls[3], and Forel says it is found on the mountains in Switzerland as high as the region of the fir trees, but also on the plains, in dry and rocky places under stones[18].

L. tuberum has not been found further north than Worcestershire in Britain.

Farren-White discovered a large colony between the laminae of a boulder of Portland stone on the Isle of Portland[29], and Perkins saw the workers running over shale in the hottest sunshine on the cliffs round Stoke Fleming, their nests being situated in cracks between the flakes of shale, the individuals in each nest, however, being few in number[27].

In 1857 Baly discovered a colony in a decaying post at Lower Shorne near Gravesend in which there were not less than one hundred and fifty individuals[13].

Nevinson found, at Lyme Regis, some rotten sticks bored by *Osmia leucomelana* lying on the ground, and on cutting one of these open to look for the cells of the bee, he came upon a nest of *L. tuberum* with undeveloped eggs. This stick he placed in a box, in the hope of obtaining the sexes. He afterwards found similar nests in the same locality, and introduced eggs from one of them into the box with the others, when he noticed that immediately the workers discovered the new eggs, they felt them with their antennae, seized them about two-thirds down, and carried them into their nest. All the eggs hatched out, and several males and females were obtained[33].

Forel observed the copulation of *L. tuberum* on the summit of Mont Tendre on August 30th, 1871, and he records isolated fertile females under bark at Vaux and Zurich in the spring[19].

Nylander records the capture of a winged female by Dahlbom at Thorsborg on July 14th, 1841[7], Curtis beat two males and two workers out of a privet hedge in the Folkestone road near Dover on July 31st, 1852[9], and I found the male in a nest at St. Margaret's Bay on August 25th, 1907. On August 23rd having swept workers from the grass on the slope of the undercliff I determined to try and find their nest, and this I succeeded in doing on the 25th, when a small colony was found under a stone in company with *Acanthomyops niger*, and on digging up the chalky ground under the stone, a male, deälated female, and a number of workers were secured[35].

Fletcher bred males from eggs laid by workers in captivity. At the beginning of April, 1887, he found a nest of *L. tuberum* under the bark of a scrubby old maple at Worcester, and collected the colony into a tin, but in doing so he lost the queen, as on reaching

home he only found workers present. These he fitted up in a flower-pot partly filled with earth, moss, and pieces of bark, and on examining the nest in July he was astonished to see a number of larvae present, and three weeks later he observed several cocoons (he must have meant pupae, as the pupae of *Leptothorax* are always naked). Late in September males began to appear, twenty-one in all being reared[25]. Saunders unfortunately records them as the males of *L. nylanderi*[30], but the specimens, males and workers, are undoubtedly the *L. tuberum* F.

Crawley found a small colony in June, 1912, at Seaton in Devon, in moss under flints on the cliffs, consisting of sixteen workers, one male, several pupae of all castes, and larvae. Specimens from this colony were named by Forel—" *L. tuberum* F. var. approaching *interruptus* Sch.," but as Crawley says it can only be considered a very slight variety of *tuberum, s. str.*, and he describes it as follows[40] :—

" ☿ Thorax finely rugose. Spines as in *tuberum* (*s. str.*). Reddish yellow ; club of antennae, front of head, but not vertex, and an irregular patch on the base of first segment of gaster, dark brown. L. 2·5 mm.–2·7 mm."

" ♂ Joints 2–5 of funiculus much longer than broad, but not so long as in the preceding (*tuberum, s. str.*). Mandibles quinquedentate. Head, thorax, and pedicel finely rugose ; gaster smooth and shining. Epinotum without tooth-like tubercles. Brown-black ; mandibles, antennae, and legs paler L. 2·7 mm."

Adlerz describes an ergatandromorph of *L. tuberum*[24] :—

Incomplete lateral ergatandromorph. Right side exclusively worker, left partly male and partly worker. Left half of head male, pronotum worker, mesonotum, paraptera, scutellum and mesopleurae male ; metanotum and epinotum worker ; legs male with worker colouring. Petiole and post-petiole between male and worker, but left side darker like that of the male. Gaster as in the worker, but on the left side of tip with an incomplete sternite, representing the seventh segment of the male. There is a projecting, irregular penis, with its genital valves so abortive on the right side as to be recognizable only with difficulty. At the right of the penis is a rather irregular sting.

Leptothorax interruptus Schen.

Myrmica interrupta Schenck Jahrb. Ver. Naturk Nassau **8** 106–107[1] 140[2] 145[3] (1852). *Leptothorax interruptus* Mayr Verh. Zool. Bot. Ver. Wien **5** 446 (1855)[4]. *Myrmica* (*Leptothorax*) *simpliciuscula* Nylander Ann. Sc. Nat. Zool. (4) **5** 92 (1856)[5]. *Leptothorax tuberum* r. *interruptus* Forel Denksehr. Schweiz. Ges. Naturw. **26** 85[6] 228[7] 415[8] (1874). *Leptothorax tuberum* var. *interruptus* Er. André Spec. Hym. Europe **2** 299 (1881)[9]. *Leptothorax interruptus* Dalla Torre Cat. Hym. **7** 124 (1893)[10] ; Bondroit Ann. Soc. Ent. Belg. **55** 12–13 (1911)[11]. *Leptothorax tubero-affinis* (*teste Forel*) Donisthorpe Ent. Rec. **24** 306 (1912)[12]. *Leptothorax tuberum* var.* *tubero-affinis* Donisthorpe Ent. Rec. **25** 63 (1913)[13]. *Leptothorax affino-tuberum* Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 20–21 (1913)[14]. *Leptothorax tuberum* subsp. *interruptus* Crawley Ent. Rec. **26** 94, 96, 108 (1914)[15]. *Leptothorax* (*Leptothorax*) *tuberum* subsp. *interrupta* Emery Bull. Soc. Ent. Italiana **47** 175 (1916)[16] : Gen. Ins. **174** 256 (1922)[17].

☿ *Reddish yellow, with the front of the head, and the club of the antennae blackish; gaster with a more or less distinct brown patch at the base of the first segment, often interrupted in the middle, and extending up the sides of the segment, legs, mandibles, and the rest of the antennae yellow, or reddish yellow.*

Head rugose, finely striate; *clypeus* as in *tuberum*; *antennae* twelve-jointed. *Thorax* slightly more finely rugose than the head, no impression between mesonotum and epinotum; *epinotal* spines long, narrow, curved, about two-thirds as long as the basal face of the epinotum. *Pedicel* a little more finely rugose than the thorax; *gaster* smooth and shining. *Legs* without erect hairs. *Long.* 2·3–3·4 mm.

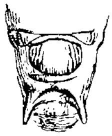


Fig. 80. Scutellum and epinotum of *Leptothorax interruptus* ♀.

♀ *Club of antennae, head, thorax, and pedicel black, mandibles, legs, and the rest of the antennae yellow; gaster blackish brown with a narrow yellow band at the apex of all the segments.*

Head longitudinally striate, rugose; *clypeus* as in *tuberum*; *antennae* twelve-jointed. *Thorax*: *mesonotum* finely longitudinally striate; *scutellum* smooth and shining in the centre; *epinotal spines* longer than in *tuberum*. *Pedicel* rugose; *gaster* smooth and shining. *Wings* clear; *radial cell* small and closed. *Long.* 3·7–4·5 mm.

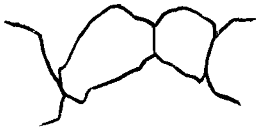


Fig. 81. Pedicel of *Leptothorax interruptus* ♂.

♂ *Black, mandibles, antennae and legs pale dirty brownish yellow, with the articulations of the legs and tarsi lighter.*

Head finely rugose; *mandibles* quadridentate; *antennae* thirteen-jointed, *scape* as in *tuberum, funiculus* with joints two to five as broad as long. *Thorax* finely striate longitudinally; *mesonotum* at the sides and *scutellum* in the centre more finely striate than the rest of the thorax, which gives the appearance of being smooth and shining; *epinotum* armed with two blunt tooth-like tubercles. *Petiole* finely rugose, viewed in profile rising posteriorly to a high point, descending vertically and then continuing horizontally to its junction with the post-petiole; *post-petiole* higher than long; *gaster* smooth and shining. *Wings* as in the ♀. *Long.* 2·5–3 mm.

Original description of *Myrmica interrupta* Schenck [Jahr. Ver. Naturk. Nassau **8** 106 (☿), 107 (♀), 141(♂) (1852)] :—

" A. ¾ bis 1 L. *Gelb oder röthlichgelb, der Vorderleib in der Regel von letzterer Farbe. Kopf vornen nach dem Unterrande hin braun, Scheitel gelb; Fühlerkeule braun; am Ende des Segments befindet sich eine von aussen nach innen verschmählerte, mitten unterbrochene braune Binde* (oder zwei dreieckige braune Flecken), oft auch fehlend, oder nur durch eine bräunliche Färbung angedeutet sonst ist der Hinterleib gelb. Der ganze Körper mit abstehenden Borsten

besetzt, die Beine kahl. Kopf lang, viereckig, merklich breiter, als der Thorax, fast von der Länge desselben, nicht ausgerandet, fein längsgestreift. Die Fühler 12-gliedrig. Die Stirnlappen sind etwas seitlich verlängert und aufwärts gebogen. Thorax äusserst fein unregelmässig gerunzelt, die Brustseiten sehr fein längagestreift. Die Dornspitzen des Metathorax *lang, schief aufwärtsgerichtet, etwas gebogen.* Hinterleib kurz, rundlich, ohngefähr von der Länge des Thorax.

W. (nur im ungeflügelten Zustand mir bekannt). 1½ bis 1¾ L. *Blassbraungelb, der Hinterleib gelb: braun sind Kopf, Fühlerkeule, Schildchen, und eine breite Binde auf jedem Hinterleibsring,* fast den ganzen Ring einnehmend, nur am Border- und Hinterrande einen schmahlen gelben Streifen übrig lassend, der am Vorderrand breiter. Kopf vornen ziemlich grob längsrunzelig, neben netzrunzelig, Kopfschild glänzend, weniger gerunzelt; Stirnfeld nicht deutlich begrenzt; Stirnlappen seitlich erweitert, aufgebogen. Fühler 12-gliedrig, *Keule braun.* Thorax fein und dicht längsgestreift, Schildchen mehr oder weniger glatt und glänzend, höchstens am Anfang oder auch noch am Ende hin längsgestreift. Metathorax mit *zwei kurzen starken, spitzen Dornen,* fast gerade ausgestreckt, zwischen und unter denselben dicht regelmässig quergerunzelt. Hinterleib rundlich, der ganze Körper kurz und gedrungen. Beine gelb, die Schienen mit anliegenden Börstchen."

"Das Männchen ist etwas länger, als der Arbeiter, aber sehr schlank, von der Gestalt des M. der *M. unifasciata* und *cingulata.* Tief braun-schwarz, Hinterleib sehr glänzend; Fühler braun Hüftglieder und Schenkel braunschwarz, Schienen braun, Basis und Spitze der Schenkel und Schienen blassgelblich, Tarsen blassgelblich oder bräunlich und nur die Spitzen der Glieder blass. Flügel ganz wasserhell. Der Kopf klein, die Kiefer gelblich; Netzaugen sehr dick, weit unten sitzend, Kopf und Thorax fein längsstreifig. Fühlerschaft ohngefähr dem dritten Theil der Geissel gleich. Der zweite Knoten in den Stiel allmählig verschmählert. Metathorax mit 2 kurzen Zähnchen. Von dem M. der *unifasciata* und *cingulata* durch die Farbe der Fühler und Beine verschieden."

Habitat.

L. interruptus is found here and there in Central and Southern Europe and appears to be rare.

British distribution :—

Hants, S. : New Forest (*Crawley* and *Donisthorpe*)[12].

This pretty little species was discovered by Crawley and myself in the New Forest in a sandy place sparsely covered with fir trees on July 23rd, 1912, when a number of small colonies was found under stones, often in connection with nests of *Tetramorium caespitum*[12].

Many colonies contained males, winged and deälated females, some males, but no winged females, others no winged forms, but several deälated females in each, and in one a single deälated female was present.

Several large specimens (3·4 mm. in length) occurred among the workers in these nests, in which the head is nearly entirely black above, and more rugose than in the ordinary worker, the gaster long, and the band, interrupted in the centre, on the first segment, distinct, the other segments being also banded

Specimens sent to authorities on the Continent were named *L. tuberum* var. *tubero-affinis*, and subsequently *L. interruptus*, the latter being undoubtedly correct. As Crawley points out, the form of the pedicel in the male of *interruptus* distinguishes it from the males of the others, and as the pedicel in the male of *affinis* is even more elongate than in the male of *tuberum*, the former is still further removed from the New Forest specimens[15].

L. interruptus chiefly nests under stones, though Forel records it as rare in Switzerland in dead wood and under bark[7] (but also under stones), Bondroit says it occurs especially under stones, and rarely in moss, and he once found a small colony in an empty snail-shell in Belgium[11], and Schenck observed it under moss and turf, and running about amongst grass at Nassau[1].

The winged forms occur in June and July, Forel found males and winged females in the nests at Vaux from June 27th to July 17th[8], Schenck observed a winged female, two males, and a number of sex pupae in a nest on the slope of a mountain on June 26th[2], and subsequently, in the same place, many winged females and one male[3]; he also records several deälated females in each nest in the spring and late summer[1].

Crawley found a deälated female *interruptus* in the earth of a *Tetramorium* nest; colonies of the *Leptothorax* and *Tetramorium* would not mix in captivity, but he united two colonies of the former in an observation-nest, which placed their broods in a single pile, and mingled together without any animosity[14].

On June 23rd, 1913, when in the New Forest locality, I again found a number of colonies of *L. interruptus* under stones—some in connection with *Tetramorium* nests—which contained workers, deälated females, and larvae, but no winged forms nor pupae were present. One of these, in which three deälated females were present, I brought home, and established it in a "Crawley-Lubbock" nest, where it lived for some years. On March 5th, 1914, larvae of *Tetramorium caespitum*, *Myrmecina graminicola*, and *Leptothorax affinis* were placed in the outer part of the observation-nest, when the *Leptothorax* larvae were carried in first, and subsequently the others. The *Tetramorium* and *Myrmecina* larvae were partly devoured in a few days and their remains buried in the earth, the *L. affinis* larvae being placed with the *L. interruptus* brood, but the former were probably eventually eaten, as I have been unable to detect any *affinis* workers, though a number of *interruptus* workers have been reared. Eggs were laid by the *interruptus* females on May 25th, 1914.

On July 24th, 1914, a number of colonies of *interruptus* were again observed in the New Forest—one of these, which contained many males and winged females, was found in the centre of a strong colony of *Myrmica scabrinodis* v. *sabuleti* situated in a mound—and workers, larvae, and pupae were brought home and

placed in the outer part of the 1913 nest. The new workers entered the nest, breaking through the earthen wall constructed by the old inhabitants of the nest and joining forces with them. No fighting took place and the ants formed one colony.

TETRAMORIUM Mayr.

[τέτρα, four ; μόριον, parts (i.e. the joints of the maxillary palpi).]

Type : **Formica caespitum L.** (Girard, 1879).

This genus is distributed over the whole world, and contains many aphidicolous species. *Tetramorium* is essentially African, but many species have reached India and New Guinea ; Europe has probably acquired its representatives from Southern Asia, and only a few more or less aberrant species are present in America. Two cosmopolitan forms, which have been carried all over the world by commerce, occur in Britain in hot-houses.

Girard [Traité. Élém. Ent. **2** 1016 (1879)] cites *Formica caespitum* L., as the type of this genus, in which he is followed by Bingham [Faun. Brit, India Hym. **2** 175 (1903)], and Wheeler [Ann. New York Acad. Sc. **21** 173 (1911) : **23** 79 (1913)].

☿ *Head* quadrangular ; *clypeus* triangular, with its posterior margins raised on each side and forming a projecting carina which borders the antennal cavities anteriorly ; *frontal carinae* projecting, short, wide apart and somewhat divergent posteriorly ; *frontal area* not sharply defined ; *mandibles* broad, with five to seven teeth on the terminal margins ; *maxillary palpi* four-jointed ; *labial palpi* three-jointed ; *antennae* twelve-jointed, *funiculus* with the last three joints forming a club, which is about as long as the rest of the joints of the funiculus taken together, last joint of club longer than the two preceding taken together. *Thorax* short ; *pronotum* broad anteriorly, with distinct anterior angles ; somewhat depressed between the mesonotum and the epinotum ; *epinotum* armed with two short spines, or pointed teeth. *Petiole* cylindrical anteriorly, nodiform posteriorly ; *post-petiole* transverse, broader than petiole ; *gaster* oval ; *sting* large.

♀ Size large, two or three times that of the ☿. Characters as in the ☿, *epinotal spines* stouter, *gaster* longer and more robust. *Wings : fore-wings* with one cubital cell and one discoidal cell.

♂ *Head* smaller than in the ♀ ; *mandibles* flat, terminal margin dentate ; *maxillary palpi* four-jointed ; *labial palpi* three-jointed ; *antennae* ten-jointed, *scape* short, *funiculus* with the second joint long, longer than scape. *Thorax : mesonotum* with Mayrian furrows ; *epinotum* slanting, armed with two very feeble teeth, or tubercles. *Wings* as in the ♀. Size a little smaller than in the ♀.

Original description [Mayr Verh. Zool. Bot. Ver. Wien **5** 423 (1855)] :—

" (τέτρα vier, μόριον Glied.*)

Arbeiter : Der Kopf ist ohne Oberkiefer viereckig mit abgerundeten Hinterecken, breiter als der Thorax. Die Oberkiefer sind breit und am Innenrande gezähnt. Die Unterkiefertaster sind vier-, die Lippentaster

* In Beziehung auf die Unterkiefertaster.

dreigliedrig. Die Oberlippe ist in der Mitte des vorderen Randes schwach stumpfwinklig ausgebuchtet. Der Clypeus ist mässig lang und breit, von vorne nach rückwärts convex, von einer Seite zur anderen fast plan. Die Stirnlappen sind ziemlich schmal. Der Schaft der zwölfgliedrigen Fühler ist nahe am Grunde etwas bogenförmig gekrümmt ; die Geissel ist keulenförmig. Das Stirnfeld ist kaum angedeutet. Die Punctaugen fehlen ; die Netzaugen sind ziemlich klein, oval und in der Mitte des Seitenrandes des Kopfes gelegen. Der Thorax ist vorne am breitesten und hinten am schmälsten. Zwischen dem Meso- und Metanotum ist oben keine Einschnürung, sondern bloss eine feine Furche. Das Metanotum ist mit zwei nach aufwärts und hinten gerichteten Dornen bewehrt. Das erste Glied des Stielchens ist vorne kurz gestielt, oben hinten knotenförmig, welcher Knoten ebenso lang als breit und etwas höher ist als der Knoten des zweiten Gliedes ; das zweite Glied ist knotenförmig, breiter als lang und breiter als der Knoten des ersten Gliedes; die Unterseite des Steilchens ist unbedornt, höchstens findet man auf dem zweiten Glied einen sehr kurzen, stumpfen, zahnartigen Höcker. Das erster Segment des Hinterleibes bedeckt mehr als dreiviertel Theile des letzteren. Die Beine sind ziemlich dick.

Weibchen : Der Kopf ist so wie beim ☿ mit Ausnahme der hier vorhandenen Punctaugen und der grösseren Netzaugen. . . . Der Thorax ist etwas vor den Flügelgelenken am breitesten ; das Mesonotum und Schildchen liegen in derselben Ebene und sind flach ; das Metanotum ist mit zwei nach hinten und aufwärts gerichteten Dörnen oder zahnartigen Höckern versehen. Das Stielchen ist so wie beim ☿. Der Hinterleib ist länglich-eiförmig, dessen erstes Segment bedeckt ein halb bis zwei Drittel desselben. Die Costa transversa verbindet sich mit der Costa cubitalis an deren Theilungsstelle, wodurch nun eine einzige geschlossene Cubitalzelle gebildet wird ; die Costa recurrens ist vorhanden, daher sich auch eine geschlossene Discoidalzelle vorfindet ; . . .

Mannchen : Der Kopf ist klein, schmäler als der Thorax. Die Oberkiefer sind schmal und gezähnt. Die Kiefertaster und Lippentaster sind so wie bei den vorigen Geschlechtern. Der Clypeus ist mässig gewölbt, ungekielt und reicht bis zwischen die Fühler. Das Stirnfeld ist undeutlich ausgeprägt. Der Schaft der zehngliedrigen Fühler ist so lang als das lange zweite Geisselglied. Die Netzaugen sind gross und hervorstehend. Das Mesonotum, welches zwei nach hinten convergirende Linien eingedrückt hat, überragt bloss das Pronotum, der Metathorax ist nicht verlängert ; das Metanotum ist mit zwei äusserst kurzen oft undeutlichen Zähnchen versehen. Das Steilchen ist ähnlich jenem des ☿ und des ♀. Der Hinterleib ist eiförmig, hinten zugespitzt und dessen erstes Glied bedeckt die Hälfte desselben. Die Flügel sind so wie beim ♀. Die Beine sind dünn und lang."

Tetramorium caespitum L.

Formica caespitum Linnaeus Syst. Nat. Ed. **10** 1 581 (1758)[1]. *Formica binodis* Linnaeus (Cent. Ins.) Amoen Acad. **6** 413 No. 94 (1763 ; 1789)[2]. *Formica caespitum* Latreille Ess. Hist. Fourmis France 50 (1798)[3]. *Myrmica caespitum* Latreille Hist. Nat. Ins. **13** 259 (1805)[4]. *Atta caespitum* Illiger Mag. Ins. **6** 194 (1807)[5]. **Formica fusca* Leach Zool. Journ. **2** 290 (1825)[6]. *Myrmica fuscula* Nylander Acta. Soc. Sc. Fenn. **2** 935 1053 ♀ ♂ (1846)[7]. *Myrmica impura* Förster Hym. Stud. **1** 48 (1850)[8] *Myrmica modesta* Förster Hym. Stud. **1** 49 (1850)[9]. *Myrmica fuscula* F. Smith Zool. **9** 3248 (1851)[10] ; Schenck Jahr. Ver. Naturk. Nassau **8** 86–91 (1852)[11]. *Myrmica atratula* Schenck Jahr. Ver. Naturk. Nassau **8** 91 (1852) ☿[12]. *Myrmica fuscula* F. Smith Zool. **11** 4080 (1853)[13]. *Myrmica caespitum* Curtis Trans. Linn. Soc. Lond. **21** 215 (1854)[14]. *Myrmica maculipes* Curtis Trans. Linn. Soc. Lond. **21** 216 (1854) ♀[15]. *Myrmica caespitum* F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 122–124 (1855)[16] : Ent. Ann. **1855** 97[17]. *Tetramorium caespitum* Mayr Verh. Zool. Bot. Ver. Wien **5** 426 (1855)[18]. *Tetramorium atratulum* Mayr

Verh. Zool. Bot. Ver. Wien **5** 429 (1855) ☿[19]. *Myrmica (Tetramorium) caespitum* F. Smith Cat. Brit. Foss. Hym. 26 (1858)[20] : Trans. Ent. Soc. Lond. (n.s.) **4** 1857 279 (1858)[21]. *Myrmica caespitum* F. Smith Ent. Ann. **1865** 89[22]. *Tetramorium caespitum* F. Smith Ent. Mo. Mag. **2** 29 (1865)[23] : Ent. Ann. **1868** 95[24]. *Myrmica caespitum* Moggridge Harvesting Ants 63 (1873)[25]. *Tetramorium caespitum* Forel Denkschr. Schweiz. Ges. Naturw. **26** 72[26] 224[27] 270[28] 412[29] (1874) ; McCook Proc. Acad. Nat. Sc. Philadelphia **1878** 15–19[30] : **1879** 156–161[31] ; Saunders Trans. Ent. Soc. Lond. **1880** 218[32] ; Parfitt Trans. Devon Assn. Sc.-Art. **12** 516 (1880)[33] ; Er. André Spec. Hym. Europe **2** 285 (1881)[34] ; Lubbock Ants, Bees, Wasps 17 (1882)[35] ; Fowler Ent. Mo. Mag. **19** 139 (1882)[36] ; Forel Bull. Soc. Vaud. Sc. Nat. **20** 23 (1884)[37] ; Perkins Ent. Mo. Mag. **27** 195 (1891)[38] ; Bignell Young Nat. **3** 255 (1892)[39] ; Dalla Torre Cat. Hym. **7** 131 (1893)[40] ; Farren-White Ants' Ways 6[41] 95[42] 242[43] (1895) ; Saunders Hym.-Acul. 33 (1896)[44] ; Marlatt U.S. Dp. Agr. Div. Ent. (n.s.) Bull. **4** 97–99 tf. 45a-g. (1896)[45] ; Rothney Ent. Mo. Mag. **35** 14 (1899)[46] ; Morley Hym. Suffolk **2** 2 (1899)[47] ; Nevinson Ent. Mo. Mag. **38** 12 (1902)[48] ; Vic. Hist. Surrey **1** 85 (1902)[49] ; Janet Obs. Fourmis 51 (1904)[50] ; Nevinson Ent. Mo. Mag. **41** 21 (1905)[51] ; Vic. Hist. Sussex **1** 131 (1905)[52] ; Pérez Soc. Linn. Bordeaux **61** XXXII–IV (1906)[53] ; Vic. Hist. Berks **1** 76 (1906)[54] ; Vic. Hist. Cornwall **1** 182 (1906)[55] ; Vic. Hist. Somerset 1 75 (1906)[56] ; Escherich Ameise 117 (1906)[57] ; Vic. Hist. Kent **1** 116 (1908)[58] ; Wasmann Biol. Centralb. **28** 353 (1908)[59] ; Donisthorpe Trans. Leicester Lit.-Phil. Soc. *12 226 (1908)*[60]. *Tetramorium caespitum caespitum* Emery Deutsch. Ent. Zeitschr. **1909** 700[61]. *Tetramorium caespitum* Wheeler Ants 154[62] 278[63] (1910) ; Donisthorpe Ent. Rec. **22** 17 (1910)[64] : Entom. **44** 390 (1911)[65] : Ent. Rec. **24** 5–6 (1912)[66] : **25** 267 (1913)[67] ; Evans Scot. Nat. **1913** 116[68] ; Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 2 21 (1913)[69] ; Schmitz Jaar. Natuur. Genoots Limburg **1915** 122[70]. *Tetramorium caespitum caespitum* Emery Bull. Soc. Ent. Italiana **47** 194 (1916)[71]. *Tetramorium caespitum* Donisthorpe Ent. Rec. **31** 1 3 (1919)[72]. Wheeler Bull. Mus. Compar. Zool. **64** 539 (1921)[73] ; Emery R. Accad. Sci. Istit. Bologna **1922** 40[74] : Gen. Ins. **174** 276 (1922)[75] ; Lominicki Bull. Ent. Pologne **4** 2 (1925)[76].

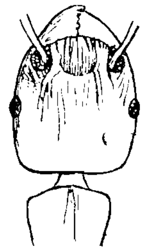


Fig. 82. Head and shoulders of
Tetramorium caespitum ☿.

☿ *Variable in colour, blackish brown to brownish yellow, with the mandibles, antennae, articulations of the legs and the tarsi yellow.*

Head and *thorax* striate longitudinally. *Petiole* and *post-petiole* wrinkled longitudinally, but generally smooth in the centre ; *gaster* smooth and shining. *Long.* 2·4–4 mm.

♀ *Blackish brown, with the mandibles, antennae, legs, and posterior margins of the segments of the gaster reddish yellow. The articulation of the legs is often lijhter.*

Head longitudinally striate. *Thorax* longitudinally striate ; *mesonotum* smooth and shining anteriorly, but with a few large scattered punctures ; *scutellum* smooth and shining. *Petiole* and *post-petiole* broader proportionately than in the ☿ ; *gaster* smooth and shining. *Pterostigma* and *nerves* of the wings dirty yellow. *Long.* 7·5–8 mm. (5–8 mm. *teste André.*)

♂ *Colour as in the* ♀.

Head striate. *Thorax* striate ; *mesonotum* transversely striate, with a space between the Mayrian furrows, and a space on each side generally smooth and shining. *Petiole* and *post-petiole* finely striate ; *gaster* smooth and shining. *Wings* as in the ♀. *Long.* 5·5–6 mm. (6–7 mm. *teste Forel.*)

Ovum : Yellowish white, round, oval.

Larva : Yellowish white ; whiter and more hairy when young ; similar to that of *Anergates*, the head, however, is furnished with short hairs, the short branching hairs scattered over the whole body are not so densely nor compactly branching, and the longer hairs are not serrate. Long anchor-tipped hairs are situated on the dorsal surface of the second to the sixth abdominal segments.

Pupa : Pale yellow, smooth and shining, as if cut out of wax.

Original description of *Formica caespitum* Linnaeus [Syst. Nat. Ed. 10 **1** 581 (1758)] :—

" F. petiolo nodis duobus alternis : posteriore majore.
Habitat in Europae *tuberibus*."

Habitat.

Tetramorium caespitum is very common in Europe and Asia, and is also found in Japan ; Wheeler records numerous workers from China, all very much like the typical European form[73]. It is rare in North Africa and is present in North America as an introduced species. A number of subspecies and varieties occur, chiefly in the Mediterranean Regions, and Lominicki records it for the Balearic Islands[76].

In Great Britain it is most common on the seashores in the south of England, but has also been found in a number of inland localities, and occurs as far north as the Bass Rock and Ailsa Craig :—

Cornwall, W. : Scilly Isles (*Farren-White*)[43] ; Tresco (*F. Jenkinson*) ; Tol-Pedn-Penwith[55] ; The Lizard (*Dale Coll.*) ; The Land's End (*F. Smith*)[22] ; **Cornwall, E. :** Pentire Point (*Rothney*)[46] ; Newquay (*Nevinson*)[48] ; St. Issey (*Crawley* and *Donisthorpe*)[66] ; Trebetherick (*Hallett*) ; Whitsand Bay (*Bignell*)[39] ; Boscastle and Downderry[55].

Devon, S. : Stoke Fleming (*Perkins*)[38] ; Dawlish (*Hamm*) ; Seaton (*Crawley*) ; Branscombe (*Farren-White*)[41] ; Haldon, Blackdown, Exmouth Warren, and Plymouth (*Parfitt*)[33] ; **Devon, N. :** Ilfracombe and Morthoe (*Saunders's Coll.*) ; Lynmouth (*Farren-White*)[43] ; Lee Bay (*Bagnall*) ; Lundy Island (*Donisthorpe*)[67].

Somerset, N. : Batheaston[56].

Dorset : Charmouth (*Dale*)[15] ; Lyme Regis (*Nevinson*)[51] ;

Wareham (*Dale Coll.*); Studland (*Morice*); Swanage (*Nevinson*); Bloxworth Heath (*O. P. Cambridge*)[72].

Isle of Wight : Sandown[14], Shanklin and Luccombe Chines[16], the Undercliff[17], and Ventnor (*F. Smith*)[20]; Landslip (*Fowler*)[36]; Blackgang Chine (*Donisthorpe*).

Hants, S. : Bournemouth (*F. Smith*)[22]; Hayling Island (*Saunders*)[44]; New Forest (*Donisthorpe*)[66]; **Hants, N. :** Fleet (*E. A. Butler*).

Sussex, E. : Hastings District[52]; Camber Sands (*Donisthorpe*); **Sussex, W. :** Arundel Park (*F. Smith Coll.*).

Kent, E. : Folkestone (*F. Smith*)[14]; Deal (*F. Smith*)[20]; Dover (*F. Smith*)[20]; Sheppey (*Champion*); Throwley[58] and Huntingfield (*Chitty*); **Kent, W. :** Darenth (*Curtis*)[14]; Plumstead Wood (*F. Smith*)[24].

Surrey : Shirley (*F. Smith*)[24]; Chobham (*Saunders*)[49].

Essex, S. : Southend (*Curtis*)[14]; Shoeburyness (*F. Smith*)[16]; **Essex, N. :** Walton-on-the-Naze (*Harwood*).

Middlesex : Hampstead Heath (*Farren-White*)[42].

Berks : Wellington College (*Barnes*)[54]; Tubney (*Donisthorpe*)[66].

Suffolk, E. : Lowestoft (*F. Smith*)[23]; Pakefield (*Morice*)[47]; Dunwich (*Farren-White*)[42]; Ipswich (*Morley*)[47]; Herringfleet (*Bedwell*); **Suffolk, W. :** Brandon District (*Perkins*)[47]; Knettish Hall Heath (*Morley*).

Cambridgeshire : Mildenhall (*D. Sharp*).

Glamorgan : Horton, Gower, and Slade Bay (*Hallett*); Caswell Bay (*Buxton*); Burry Holmes (*Harwood*).

Carmarthen : Llanstephan (*E. A. Butler*).

Carnarvon : Abersoch (*Nevinson*); Deganwy District (*W. Gardner*).

Pembrokeshire : Tenby (*Donisthorpe*); St. Davids (*Allen*).

Isle of Man : (*Blair*).

Haddington : Bass Rock (*Evans*)[68].

Clyde Isles : Ailsa Craig (*Bagnal*).

Tetramorium caespitum prefers to nest in open country and occurs in sandy places, on banks, in fields, etc. Schenck[11] records it in woods on the Continent, but Forel[27] states this is seldom the case, and I have never found it in woods in Britain. It occurs in the New Forest, but is there confined to open sandy heaths, where only a few scattered fir trees are present. In Switzerland, according to Forel, *T. caespitum* ranges as high as the region of the fir trees[27], and I found it, in October, 1912, on Les Agittes, nesting between the interstices of a wall of rock

Its nests are often deep in the ground, and are frequently situated under stones, but are sometimes covered with a dome of earth of considerable proportions, and small secondary domes may also be present. Long narrow galleries extend, just beneath the surface, right round these domes, and very small holes, often

closed with grains of earth, connect these galleries with the open air. In July, 1918, I found a small nest situated by the side of a road in the New Forest, which consisted of a small cone, about 1½ inches high, built of tiny pebbles. Other colonies were seen nesting in the flower-beds in the Beaulieu Road Hotel garden[72].

P. Harwood sent me workers taken in gulls' nests in Glamorgan in May, 1926.

Mayr[18] says it not infrequently lives in houses on the Continent, and this also appears to be the case in America, where this ant has been introduced from Europe. Wheeler writes—the pavement ant (*T. caespitum*) of Europe is now common about New York, Washington, and Philadelphia, but it is so sporadic that we must conclude either that it is of comparatively recent importation, or is prevented from spreading by competition with our native ants[62]. Marlatt says the pavement ant of our Eastern cities is the common meadow ant in Europe, and is very common in the eastern towns and particularly in Washington, having colonies beneath the pavements, and is often a more pernicious and pestilent house nuisance than the true house ant. He goes on to say that it seems to be the species referred to by Kalm in 1748 as often occurring in houses in Philadelphia[45].

The colonies of this *Tetramorium* are often very populous, their nests being very extensive, and their enormous females are certainly capable of founding colonies unaided. In July, 1906, Wasmann found a number of deälated females, after the marriage-flight, at Hohscheid in Ösling, Luxemburg, some under stones in little cells. He took seven females and put them with damp earth in an observation-nest, where they fought each other. On September 4th there was only one female surviving, enclosed in a cell with eggs and small larvae[59].

The marriage-flight takes place chiefly in July, but also occurs from the end of June to well into September according to Schenck[11]. Forel has seen the males and females leaving the nest as early as six o'clock in the morning at Lugano on July 1st, 1871[29]. The male and female being nearly the same size, the latter does not carry the former during the marriage-flight. I have found males and winged females in the nests in June, July, and the beginning of August.

Forel records quite small larvae in nests on October 9th[29], Bignell found young larvae on May 6th at Whitsand Bay[39], and I have taken young larvae in the nests at Tenby in April, but larvae appear to be present all through the year.

The workers of this ant are very courageous, fierce, and quarrelsome, they are robust and their bodies are very hard, their gait is rather quick, and they follow each other in files, but also go out alone on foraging expeditions. They carry their fellows over the back in the same manner as previously described for *Myrmica.*

Lord Avebury states that *Tetramorium caespitum* has the habit

of feigning death ; he says that this species, however, does not roll itself up, but merely applies its legs and antennae closely to the body[35]. I have not witnessed this, nor have I ever been able to get the ants in my observation-nests of this species to exhibit this phenomenon.

These ants are carnivorous, but also like sweet food, Forel having noticed them entering the corollas of Stachys plants to suck the nectar[29], and they cultivate root *Aphidae* in their nests, but do not appear to seek other species which occur on plants. They also exhibit a tendency to collect and harbour seeds in their nests, more particularly in warm climes, such as Algeria, where they construct special chambers to act as granaries. André had sent to him, in the month of December, a number of seeds of a dirty yellow colour, from such a granary of this ant at Oran[34]. Moggridge records that this species may occasionally be seen collecting and carrying seeds into its nests at Mentone and Cannes[25].

Farren-White says he found this species manifesting harvesting instincts at Branscombe in Devonshire[41]. He noticed the diligent workers filing into their nest with grass-seeds in their mandibles, and on disturbing their habitation he found many seeds scattered among the débris of what he took to be their granary[42]. Janet records that at Beauvais it is not rare to find accumulations of seeds in the nests of this ant, and that at Bois du Montois he found, on September 3rd, a cupful of the little seeds of Mercurialis and Paniscum heaped up in a chamber in a nest situated under a stone. He noticed that those seeds which were deepest in the earth had germinated, whereas the ones which were least exposed to moisture had not done so[50]. Escherich, in the hot summer of 1904, repeatedly found stores of seeds in the nests of *T. caespitum* at Strasburg, a fact which he had not observed in former years[57] Wheeler remarks that it is interesting to note that this ant occasionally stores seeds in the chambers of its nests. He has seen the chambers of a colony of this ant near Mamaroneck, N.Y., filled with grass seeds, and he points out that in this case we have apparently either an evanescent or an incipient habit[63].

In April, 1909, I found a great number of Cardamine seeds (probably either *C. flexuosa* or *C. hirsuta*) in many nests of *T. caespitum* at Whitsand Bay[64], again in April, 1911, the same seeds were found in some of the nests of this ant at St. Issey[66], and in June, 1913, a number of *Cerastium* seeds were found in three nests of this same ant on Lundy Island[67]. All these nests were situated under stones, and the seeds occurred in chambers just beneath the stone.

Perez in 1906 records that these ants attack the tubers of potato plants, excavating more or less profound cavities, many young plants being killed in this way. He mentions that the roots of young cabbages and carrots, as well as uncultivated plants, are

also injured by *T. caespitum*, and he says it is remarkable that these facts have never been noticed before ("jusqu'a ce jour")[53]. Linnaeus, however, in the original description of this species in 1758, writes—"Habitat in tuberibus,"[1] and Forel in 1884 observed that young beet-roots were attacked by this same ant at Vaux, many of the plants dying from the injuries received[37].

Colonies of *T. caespitum* are frequently found in the proximity of other ants' nests, but there is probably no real connection between them. Forel states that it is everywhere found in perpetual competition with *Acanthomyops niger*, *A. flavus*, *Formica fusca*, and species of the genus *Myrmica*[27]. Fowler records that he discovered *T. caespitum* and *A. umbratus* in company under a stone in the Landslip near Ventnor[36], and I found a colony under the same stone as *A. flavus* on a bank at Tenby.

Battles are frequent between different colonies of *T. caespitum*, which often arise through disputes over booty. Forel graphically describes some of these battles[28]. On April 24th, 1870, he observed an immense combat, which extended over a length of thirty metres on the slope of grass at the entrance to the University of Zurich. The combat was equally violent over this whole space, and he was unable to distinguish whence each party came out. The enemies were identical in colour, size, etc., and the battle was very desperate, thousands of dead strewing the ground. He saw the combatants bending their gasters under to sting each other, and making violent efforts to carry their antagonists off. Generally three or four ants surrounded another, and when they were separated the latter was found to be half dead, having some of its members cut off. These combats lasted for over a month with variable extension and intensity; on May 20th, it being very hot, their vivacity was astonishing, but not many deaths occurred, their fury being less great. In two cases which he observed at Vaux, he was able to distinguish the nest of each party, the one being composed of ants of large size, the other of very small ones. The victorious party arrived in great haste, in a column, without separating from each other, and laid siege to the entrances of the subterranean nest of the vanquished. On one occasion he was able to recognize the cause of the trouble. After the "Amazon Ant" (*Polyergus rufescens*) had pillaged a small nest of *Formica sanguinea*, and had retired, he noticed workers of *T. caespitum* coming out of the ground, to cut up, and carry off into their nests, some pupae which were lying on the dome of the *sanguinea* nest. The workers belonged to two different colonies of *T. caespitum*, and a fierce battle soon started between them.

McCook also records similar battles in Philadelphia; he collected some of the combatants and placed them in a bottle, which contained earth, to form an observation-nest. He states that the combat lasted for over two weeks, but that if he introduced a little

eau-de-Cologne, it put a stop to the fighting, and caused the combatants to live together in amity[30, 31].

Emery[74] gives a short account of a small colony of *T. caespitum* which was brought up in captivity at Bologna.

On July 17th, 1918, he captured a deälated female at large, and she laid eggs next day. The larvae from these eggs were fed from the mouth by the mother, and also with fragments of insects. On August 21st five pupae and worker larvae of all sizes were present. Eggs were not laid in the winter, but the larvae present next spring hatched from eggs laid in September and October. The colony prospered for four years, and Emery remarks that this species readily adapts itself to any diet.

The larvae were fed with disgorged liquid food as long as they were young and gathered together in groups, but when they grew older and were separated, the workers fed them with solid substances.

Emery supplied them with bread and biscuit crumbs, " small paste " (=small macaroni), and cheese.

He tried to see if a generation of workers could be brought up on vegetable food alone, and for this purpose he only used the " small paste." He says it was quite successful, though the development of the larvae was delayed ; but as he admits a number of larvae was sacrificed by the workers as food for the other larvae, it would seem that the experiment was very doubtful.

I have kept several colonies of this ant in captivity, in observation-nests, and give a few extracts from my note-book for a nest in my possession, started in July, 1911 :—

July 8th, 1911, a deälated female and a number of workers and larvae taken under a stone at Whitsand Bay—July 12th introduced into a four-chambered " Janet " nest—July 27th pupae now present—September 9th several callows hatched—September 25th many callows now present—March 2nd, 1912, very few deaths have taken place, a small packet of eggs present ; fed with raw meat, bits of which were placed by the workers on the larvae—March 29th fed with *F. rufa* larvae and pupae—March 31st very young larvae, which are whiter than the older ones, have hatched—June 1st callows again present—June 23rd fresh eggs laid—July 19th many of the larvae are hung on to the plaster walls of the nest (by their anchor-tipped hairs)—July 24th and 25th experiments with *Anergates* females (previously recorded under *Anergates atratulus*)—September 15th all well, callows and larvae present —January 31st, 1913, numerous larvae hanging on the walls, have not increased in size during the winter—June 1st pupae present —June 17th introduced a number of *Paracletis cimiciformis* taken in *T. caespitum* nests on Lundy (these did not live longer than a month)—June 24th introduced some large dark *T. caespitum*

workers, with larvae and pupae (from a colony found in the New Forest on June 23rd), a little fighting took place—June 25th all well, no dead ants, the strange larvae and pupae have been collected with the old ones, and the strange workers are mixed with the smaller old ones and no further fighting takes place—July 10th a few small callows present, a worker observed to milk a *Paracletus*, she stroked the hind body of the "Plant-louse" with her antennae and then sucked the anus—September 1st a number of medium-sized and small larvae present—February 1st, 1914, only a few dead ants present, medium and small larvae, the female and large and small workers all well. When the queen died, in 1917, the rest of the inhabitants were let loose in the garden.

Another colony, procured in the New Forest on July 17th, 1918, was fixed up for the purpose of helping the late Dr. Chapman with his celebrated experiments with the larvae of *Lycaena alcon* and ants' nests. This is not the place to deal, except very briefly, with this subject, but it may be mentioned that various caterpillars of this butterfly sent to me by Chapman were introduced into, and lived in, this nest from September 9th to October 6th, 1918. The ants were observed to milk, feed, clean, and carry about these caterpillars; and the latter to eat some of the ants' eggs, and larvae.

The only other noticeable feature about this colony was that the workers started, on August 27th, 1918, to kill and cut up their winged and deälated females (of which a number was present), and continued doing so at intervals—the last female being killed and cut up on June 3rd, 1919.

The following myrmecophiles have been found with this ant in Britain :—

Coleoptera : *Drusilla canaliculata* F. ; and *Staphylinus stercorarius* Ol.

Formicidae : *Anergates atratulus* Schenck.

Proctotrupidae : *Tetramopria donisthorpei* Kieffer ; *T. donisthorpei* var. *femoralis* Kieffer ; *Loxotropa tritoma* Thos. ; *Gonatopus sociabilis* Kieffer ; and *G. pilosus* Th.

Aphidae : *Paracletus cimiciformis* Heyd. ; *Trama donisthorpei* Theob. ; *Forda formicaria* Heyd. ; *Pentaphis marginata* Koch. ; *P. trivialis* Pass. : and *Tetraneura ulmi* Geoff.

Coccidae : *Ripersia subterranea* Newst.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic.

Araneina : *Acartauchenius scurrilis* Cbr. ; and *Micaria pulicaria* Sund.

Acarina : *Trachyuropoda laminosa* C. and B. ; *T. canestriniana* Berl. ; *Laelaps* (*Laelaspis*) *equitans* Mich. ; *L.* (*L.*) *humeratus* Berl ; *L.* (*Hypoaspis*) *laevis* Mich. ; and *L.* (*H.*) *myrmophilus* Mich.

Crustacea : *Platyarthris hoffmanseggi* Brdt.

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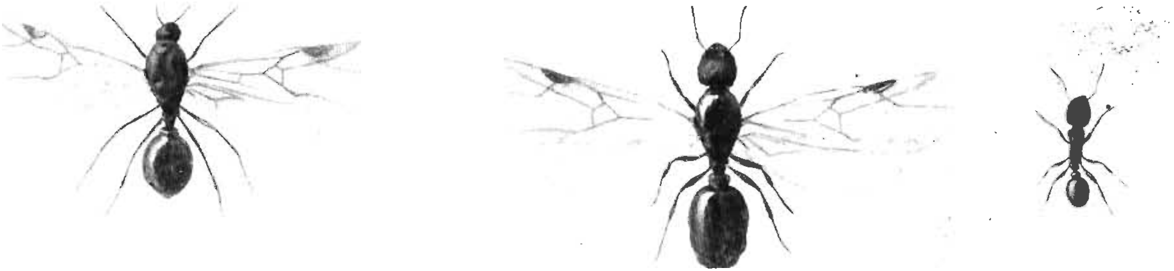
Acarina : *Trachyuropoda laminosa* C. and B.; *T. canestriniana* rl.; *Laelaps* (*Laelaspis*) *equitans* Mich.; *L.* (*L.*) *humeratus* Berl; (*Hypoaspis*) *laevis* Mich.; and *L.* (*H.*) *myrmophilus* Mich.

Crustacea : *Platyarthris hoffmanseggi* Brdt.



Male, female, and worker of *Tetramorium caespitum.*

Male, female, and worker of *Tapinoma erraticum.*

Face page 198

Tetramorium caespitum L., var. hammi Donis.

Tetramorium caespitum var. *hammi* Donisthorpe Brit. Ants 1st Edtn. 178 (1915)[1]; Emery Gen. Ins. **174** 277 (1922)[2].

☿ *Dirty yellow-brown, shining, mandibles, antennae, and legs lighter. Head* and *thorax* finely longitudinally striate; *epinotal spines* very short and pointed. *Petiole, post-petiole* and *gaster* smooth and shining. *Long.* 2·4 mm.

Described from a number of specimens taken by Mr. A. H. Hamm in the New Forest on August 25th, 1912.

The sculpture is less rugose, the spines are shorter and less robust, and the petiole and post-petiole are smoother and more shining than in the type.

This variety comes near to the var. *schmidti* Forel [Rev. Suisse Zool. **12** 15 (1904)], and the var. *semilaeve* André [Spec. Hym. Europe 2 286 (1881)], but it is not so robust as the former, the head, thorax, petiole, and post-petiole are not so broad, and the spines are smaller, finer and more pointed. Compared to the latter it is less yellow, the striation of the head and thorax is a little stronger, and the spines are a little smaller and more pointed. Hamm's specimens were all found walking about on the bare sand, within a few feet in area, but he was not able to find their nest.

Subfamily **Dolichoderinae** Forel.

This subfamily comprises a number of genera which are found all over the world, though chiefly in the Tropics; a very few occur in Europe, of which only one genus (*Tapinoma* Förster) is present in Britain.

They form a natural, very homogeneous, group, and are more primitive than the *Formicinæ.*

The gizzard is of a complex and peculiar structure, the sting is vestigial (except in one genus), nearly all the genera possess, in the female and worker, repugnatorial glands which give off a characteristic odour, which is said to resemble that of rotten cocoanuts, and has been called "*Tapinoma* odour," and the pupae are naked, never being enclosed in cocoons.

TAPINOMA Förster.

[ταπείνωμα, a lowering (i.e. the scale).]

Type: **Formica erratica** Latr. (=*collina* Förster; Först., 1850).

The genus *Tapinoma* ranges over the hot and temperate regions of the whole globe, with the exception of New Zealand, and contains some twenty-four species. Its colonies are mostly very populous

and inhabit dry places; two species being known to live in the nests of Termites.

☿ *Head* scutiform, broadest before base; *clypeus* broad, with the anterior margin deeply and narrowly excised in the centre; *frontal carinae* parallel; *frontal area* not defined; *mandibles* long, triangular, the whole terminal border dentate, with a long tooth at apex; *maxillary palpi* six-jointed; *labial palpi* four-jointed; *antennae* filiform, twelve-jointed, *scape* long, *funiculus* gradually and only slightly thickened to apex, first and last joints longer, the ones between shorter and subequal; *eyes* large, situated in front; *ocelli* wanting. *Thorax* narrower than head; *pronotum* rounded, broader than the rest of the thorax; sutures between pronotum and mesonotum, and mesonotum and epinotum distinct; *epinotum* short, unarmed, flat and slanting posteriorly. *Pedicel* furnished with a flat scale, which is bent forward; *gaster* oval, with only four segments visible from above, first segment high, rounded, and prominent, covering the scale, with a fovea in its anterior surface for the reception of the latter.

♀ Similar to ☿ but larger; *head* broader, *eyes* larger, *ocelli* present. *Wings*: *fore-wings* with one cubital cell, and one discoidal cell, the latter sometimes wanting.

♂ *Head* triangular; *mandibles* with terminal border very finely dentate; *maxillary palpi* six-jointed, *labial palpi* four-jointed; *antennae* thirteen-jointed, *scape* as long as the first five joints of the funiculus taken together. *Eyes* large, prominent; *ocelli* present. *Wings* as in the ♀. *Pedicel* broad, rounded above; *gaster* longer than in the ♀; *external genital organs* large.

Original description [Förster Hym. Stud. 1 43 (1850)] :—

" **Tapinoma n. gen.***

Palpi maxillares 6-articulati, labiales 4-articulati, dimidia longitudine priorum breviores. Antennae filiformes, infra medium faciei insertae; clypeus mediae magnitudinis, apice medio profunde exciso; squama abdominis segmenti primi oblonga, subrectangularis, depressa, foveola basali segmenti secundi recepta, vix conspicua."

Tapinoma erraticum Latr.

Formica erratica Latreille Ess. Hist. Fourmis France 44 (1798)[1]. *Formica caerulescens* Losana Mem. Accad. Sc. Torino **37** 314 (1834)[2]. *Formica glabrella* Nylander Acta. Soc. Sc. Fenn. **3** 38 (1849)[3]. *Tapinoma collina* Förster Hym. Stud. **1** 43 (1850)[4]; Schenck Jahr. Ver. Naturk. Nassau **7** 67 136, 139 (1852)[5]. *Tapinoma erratica* F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 111–112 (1855)[6]. *Formica coerulescens* Mayr Verh. Zool. Bot. Ver. Wien **5** 371 (1855)[7]. *Tapinoma erraticum* Mayr Verh. Zool. Bot. Ver. Wien **5** 373 (1855)[8]. *Tapinoma erratica* F. Smith Ent. Ann. **1856** 96[9]. *Micromyrma pygmaea* Dufour Ann. Soc. Ent. France **26** (**3** s. **5** : **1857**) 60 (1857)[10]. *Tapinoma erratica* F. Smith Cat. Brit. Foss. Hym. 16–17 (1858)[11]: Ent. Ann. **1865** 88[12]: **1866** 128[13]: **1869** 75[14]. *Tapinoma erraticum* Forel Denkschr. Schweiz. Ges. Naturw. **26** 60[15] 166[16] 222[17] 330–336[18] 410[19] (1874). *Micromyrma Dufourii* Perris Ann. Soc. Ent. France **46** (**5** s. **7** : **1877**) 379–382 (1878)[20]. *Tapinoma erratica* Parfitt Trans. Devon Assn. Sc.-Art. **12** 514 (1880)[21]; Saunders Trans. Ent. Soc. Lond. **1880** 210[22]. *Tapinoma erraticum* Er. André Spec. Hym. Europe **2** 222–224 (1881)[23]. *Tapinoma erratica* Bignell Young Nat. **3** 207 (1882)[24]. *Tapinoma erraticum* Lubbock Journ. Linn. Soc. Lond. Zool. **20** 129 136 (1888)[25]; Wasmann zusam. Nest. u. gemischt. Kolon. Ameisen 257 (1891)[26];

* "Tapinoma von ταπείνωμα das Erniedrigte.—Der Name enthält eine Andeutung auf die niedergedrückte Schuppe des 1sten Segments."

Ferton Act. Soc. Linn. Bord. **44** (5 ꝗ. 4 : **1890**) 341–346 (1892)[27]; Dalla Torre Cat. Hym. **7** 164 (1893)[28]. *Tapinoma erratica* Farren-White Ants' Ways 236–237 (1895)[29]. *Tapinoma erraticum* Saunders Hym.-Acul. 27 (1896)[30]; Service Scott-Elliott's Flora Dumfriesshire XV (1896)[31]. *Tapinoma erratica* Saunders Ent. Mo. Mag. **36** 14 (1900)[32]. *Tapinoma erraticum* Escherich 87–88 218 (1906)[33]; Santschi Journ. Psychol-Neurol. **13** 146–148 (1908)[34]; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 225 (1908)[35]: Ent. Rec. **20** 282 (1908)[36]: **21** 258 (1909)[37]; Morley Morey's Guide NH. Isle of Wight 303 (1909)[38]; Donisthorpe Entom. **44** 390 (1911)[39]: Ent. Rec. **24** 6 (1912)[40]; Emery Genera Insect. **137** 40 (1912)[41]; Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 23 (1913)[42]; Donisthorpe Ent. Rec. **25** 63 (1913)[43]: **26** 39 (1914)[44]; Emery Bull. Soc. Ent. Italiana **47** 217 (1916)[45]; Donisthorpe Ent. Rec. **28** 37 (1916)[46]: **31** 2 (1919)[47]; Lominicki Bull. Ent. Pologne **4** 2 (1925)[48].

☿ Black, mandibles, and often the antennae and legs dark brown, tarsi and articulations of the joints of the legs yellowish. The whole body covered with white pubescence, very finely punctured, somewhat shining. *Long.* 2·6–4·2 mm. (2·2–3·8 mm. *teste Forel.*)

♀ Very like the ☿; slightly more pubescent and punctured. *Wings* somewhat fuscous. *Long.* 4·5–5·8 mm. (4·5–5 mm. *teste Forel.*)

♂ Colour, puncturation, and wings as in the ♀. *Long.* 3·4–5 mm.

Ovum : White, round oval.

Larva : Yellowish white, narrow and pointed anteriorly and posteriorly, with the segments clearly defined. The ventral surface is sharply angled from the first abdominal segment to the pointed apex; the dorsal surface is broadly rounded, the prothoracic segment more prominent. The smaller larvae are almost glabrous, but under a high power short bristles can be seen, chiefly on the ventral surface. The larger larvae are quite glabrous, shining, and more " sausage " shaped.

Pupa : Yellow, transversely striate, wax-like.

Original description of *Formica erratica* Latreille [Ess. Hist. Fourmis France 44 (1798)] :—

" 24. F. errante, *erratica*.

O.t.p. Noire, glabre, luisante. Extrémités des cuisses et des jambes, tarses, pâles. *Male.* Tête et corcelet d'un noir clair. Base des antennes, pattes, pâles. Aîles obscures. *Femelle.* Noire, veloutée. Jambes et tarses testacés. Nervures jaunâtres à la base des aîles antérieures."

Habitat.

Tapinoma erraticum is found in Central and Southern Europe, on the shores of the Mediterranean, in the Caucasus, and Central Asia. Lominicki records it from the Balearic Islands[48]. Three varieties and two subspecies occur.

In Britain it is almost confined to the South of England, but has been recorded from Scotland, as F. Smith writes that Dale took workers in Scotland in 1846[6]—the insect he describes is certainly *T. erraticum*—and Service speaks of it as a very scarce species in Dumfries[31]. It is very remarkable that there are no records of its capture farther north in England than Surrey.

Cornwall, W. : Scilly Isles (*Dale*)[30]; Land's End (*F. Smith*)[12].

Devon, S.: Bovey Heathfield (*Parfitt*)[21]; Bovey (*Bignell*)[24]; Bovey Tracey (*Hamm*).

Dorset: Lulworth (*Farren-White*)[29]; Wareham (*Dale*)[32]; Studland (*Morice*)[35]; Chapman's Pool (*E. A. Butler*)[35]; Ringstead and West Knighton Heath (*Haines*); Bloxworth (*O. P. Cambridge*).

Isle of Wight: Parkhurst Forest (*E. A. Butler*)[38].

Hants, S.: Bournemouth (*Dale*)[6]; New Forest (*Hamm*)[35]; near Lymington (*Jones*); **Hants, N.:** Harford Bridge Flats (*E. A. Butler*); Fleet (*Hodson*).

Sussex, W.: Harting (*Beaumont*)[32].

Surrey: Coombe Wood and Weybridge (*Grant*)[9]; near Guildford (*Stevens*)[11]; Chobham (*Saunders*)[22]; Shirley (*Farren-White*)[29]; near Croydon (*Saunders*)[22]; Woking (*Donisthorpe*)[35].

Dumfries: Dumfries (*Service*)[31].

This ant loves dry places exposed to the sun, and occurs chiefly on sandy heaths and commons in Britain. In Switzerland it ranges as high as the sub-alpine regions, Forel having found it at a height of 1200 metres on the Rigi, etc.[17] It nests in the earth, under stones, on banks, etc., but its subterranean galleries do not extend very deeply into the ground, and temporary domes of variable sizes are built of earth and other materials in order to concentrate heat and to help to hatch the eggs and pupae. These domes sometimes consist of masses of earth built around the stems of grass and other herbage above the chambers of the nest which are underground. A mound nest of *Tapinoma erraticum* which I found in the New Forest was built of bits of burnt heather, grass, and grains of sand, etc., about six inches high and the same in diameter.

Santschi describes eleven different methods in which this ant constructs its nests in Tunis[34].

T. erraticum has a rather soft body, but is very agile, darting rapidly about in the sunshine, its antennae continuously vibrating, and its gaster, which is very mobile, being raised when the ant is in motion. When the sun is obscured these ants immediately disappear, and on cold and cloudy days very few specimens are to be found away from the nest.

They frequently leave their nesting-place and migrate to a fresh one—generally near at hand, but sometimes at some distance from the old one—when they follow one another in files, carrying their larvae and pupae, the males and winged females following in the procession, the whole process not lasting much longer than an hour. The fertile females carry about the eggs and larvae, and the workers sometimes carry their fellows, in which case the carrier seizes the other ant by the thorax, or a leg, and runs off with her, the latter keeping the legs and antennae closely folded against the body as if she were a pupa.

The pupae (as we have seen is the case with all ants of the subfamily to which this species belongs) are always naked, but F. Smith writes in 1856—" On the last occasion of Mr. Grant's visiting the colony of *Tapinoma*, at Coombe Wood, the males and females were in the pupa state, spun up in silken cocoons."[9] This undoubtedly shows that on this occasion the ant in question certainly was not *Tapinoma erraticum*, but most probably *Acanthomyops niger*.

This ant is chiefly carnivorous, but will eat a little honey, or sugar ; it is said not to keep *Aphidae* in its nests, but Santschi tells me it does so in Tunis, and I found many individuals of an *Aphid new to science present in nests of the subspecies *nigerrimum* Nyl., in Sicily ; and but rarely visits those on plants, though Ferton speaks of it as attending and guarding these insects[27] ; and Pérez records that it attends and absorbs the secretions of *Tettigometra obliqua*.

It haunts the battle-fields of larger ants, and carries off the dead bodies of the slain, to be cut up and devoured at home. If these ants, when out hunting, find a dead insect, they immediately seize it and drag it along to their nest, but they will also attack and kill flies and other small insects. On May 29th, 1915, I observed a worker of this ant at Woking carrying a minute yellow insect, which proved to be the larva of a Thrips[46]. They also often feed on dead birds, according to Escherich[33], and probably any other carrion will occasionally attract them.

The repugnatorial glands possessed by this species enable it to hold its own when coming in contact with other and larger ants, as it ejects the secretion contained in these glands, presenting its mobile gaster in the face of the foe, and smearing the latter with this liquid, which is of a very irritating and fatal nature. The odour of this secretion is exactly similar to that given off by beetles of the genus *Myrmedonia*, and other *Staphylinidae*, inhabiting ants' nests, and by which I have shown they protect themselves against the attacks of their hosts.

Forel describes how workers of *Formica sanguinea* are repulsed when attacking a colony of migrating *T. erraticum*, five or six of the latter applying their gasters to the head of one of the larger ants, which fall back with extraordinary contortions. He also mentions how workers of *Tetramorium caespitum* treated in the same manner by the *Tapinoma*, rub the head on the ground, and roll over in great distress[18]. I have experimented with workers of *T. erraticum* and other species of ants in my observation-nests—when introduced into a nest of *Acanthomyops fuliginosus* and attacked by one of the workers, the *Tapinoma* poked her gaster into the face of the latter, which immediately fell back, grovelling on the ground, rubbing the chin on the floor of the nest, and behaving as if it had a stroke—another specimen was enclosed in a small

* *Paracletus donisthorpei* Laing.

box with a worker of *Formica rufa* ; the latter seized the *Tapinoma*, but quickly let go, and ran round and round in a circle, being evidently much upset—similar experiments with other species produced the same results.

Colonies of *T. erraticum* are sometimes small, but occasionally very populous ones occur. Wasmann records a very strong colony he found in the Brandnertale near Bludenz at the height of 1000 metres[26], and I found a very large colony at Weybridge on July 29th, 1913, the deälated females and the workers in this nest being the largest specimens of this ant I have ever seen[44].

A number of deälated females are sometimes present in the same nest; Schenck mentions a nest at Nassau which contained between thirty and forty deälated females[5], and Crawley and I found another in the New Forest, on June 23rd, 1912, in which over twenty such females were present[42].

The fact that so many queens are found in the same nest indicates the reception of females into the parent nest after the marriage-flight, or the joining together of several females to found their colony. Sometimes, however, as pointed out by Forel[19], virgin females lose their wings without leaving the nest, and Schenck even suggested that the winged females did not leave the nest at all for the marriage-flight[5].

Judging from the size of the female, it is highly probable that they can found a colony without the aid of any workers.

Males and winged females are to be found in the nests in June, and generally occur in the same nest. In the mound nest before mentioned which I discovered in the New Forest on June 23rd, 1913—the nest having been traced by carefully watching the workers in the neighbourhood, only a few being out as the day was cold and cloudy—very many winged females, but only a few males, were present; it also contained two deälated females, a large number of workers, male, female, and worker pupae, and some larvae[44].

On June 18th, 1926, when at Bovey Tracey, I found several colonies of this ant, in the nest of which numerous winged females, but very few males, were present.

The marriage-flight takes place in June, though in cold years it is later, occurring in July. Forel saw males and winged females leave a nest at Zurich on June 14th, 1868, and he states that a second generation, of males only, is sometimes produced in September[19]. The male being about as large as the female, he is not carried in the air by the latter during the marriage-flight.

The eggs are laid during the first warm days of spring, and the sex pupae appear in the nests in May and June.

I have kept several observation-nests of this ant, but they have never been very successful—the ants in a colony without a queen taken at Woking on May 9th, 1909, devoured all their larvae and pupae, and also eggs laid by one of the workers, although plenty of

food (honey, caterpillars, and pupae of other ants) was given to them[37]—another colony containing a deälated female taken at Woking on May 18th, 1911, behaved in precisely the same manner—a third colony, found under a stone on a bank in the same locality on May 12th, 1912, contained three queens and a number of male and female pupae. In spite of the fact that the ants were supplied with plenty of food, the workers devoured all the sex pupae ; workers, however, were reared, and the colony was kept for some time[43]—I possessed a colony in captivity, part of the inhabitants of the New Forest mound nest, consisting of the two deälated females and a number of workers. Very few deaths occurred and all the ants were in good health, but eggs laid by the queens from time to time always disappeared.

Forel also records that the male and female pupae in a colony he had in captivity were all devoured by the workers[18]. Dr. Ernst, on the other hand, told me he has experienced no difficulty in keeping this species in confinement.

Lord Avebury published a figure of one of his ant-cases containing *Tapinoma* in captivity, in which the earth can be seen to have been arranged by the ants into a sort of circular fortification, or zareba, access to which is obtained by one or two tunnels, not visible in the illustration, and to which a pathway leads from the entrance[25].

The following myrmecophiles have been found with *Tapinoma erraticum* in Britain :—

Coleoptera : *Myrmoecia plicata* Er.
Braconidae : *Pachylomma buccata* Nees.
Diptera : *Pseudacteon* (=*Phora*) *formicarum* Verrall.
Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic.

Subfamily **Formicinae** Lepelletier.

This is the highest subfamily ; it is very extensive and comprises a number of genera—only two of which, *Acanthomyops* and *Formica*, occur in Britain—and very many species.

The pedicel in these species always consists of but a single segment, the petiole, and the sting is transformed into a small vestigial apparatus, consequently these ants are unable to sting, but some of them produce poison copiously, and can eject it to a considerable distance.

Their pupae are usually enclosed in cocoons, but are sometimes naked.

Table of the Genera.

☿

1 Frontal area triangular, distinctly defined ; ocelli distinct . 2 *Formica* L.

– Frontal area rounded behind, not distinctly defined, ocelli not distinct ------------------------------ *Acanthomyops* Mayr.

♀

1 Joints 2–5 of funiculus longer than the succeeding ones; frontal area distinctly defined . . . . *Formica* L.
– Joints 2–5 of funiculus not longer than the succeeding ones; frontal area not distinctly defined – – – – – – – – – – – – *Acanthomyops* Mayr.

♂

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– First joint of funiculus not broader than the rest; external genital organs large; size nearly equal to ♀ – – – – – – – – – – – *Formica* L.

ACANTHOMYOPS Mayr.

= *Lasius* F. (nec Jurine).

Type: **Formica clavigera** Roger (**claviger** Mayr; Mayr 1862; Wheeler 1911).

The ants of this genus belong to the purely north temperate fauna, being common to the Palaearctic and Nearctic Regions, and species have been found in the Baltic amber.

They do not stand as high on their legs, and are less active than the ants of the genus *Formica*, the workers follow each other in files, often using well-beaten tracks, and they never carry their fellows.

In finding their way, they do not use their eyes, but rely on the senses of smell and touch.

Some species lead an out-of-door life, but others are very subterranean in their habits, the workers seldom coming above ground.

The nesting habits of *Acanthomyops* are very diverse, some make carton nests, and they live in holes in trees, in old tree stumps, in roots, under stones, in earth mounds, in banks, and also under the pavements and in masonry in the centre of towns.

These ants are very fond of sweet liquids, but will devour small insects, etc., and also collect the seeds of plants.

They keep droves of Aphids and Coccids, pasturing them on roots and stems of subterranean plants; some species attend *Aphidae* on plants and trees above ground, and also milk Lycaenid larvae (the caterpillars of the "Blue" Butterflies).

They build covered ways from their nests, and earthen pavilions in which to shelter their plant-lice, etc. They even collect the eggs of *Aphidae*, storing them in their nests during the winter, and when these hatch, they carry the young plant-lice out and place them on their proper food-plants.

The colonies of *Acanthomyops*—which are generally large, and often very populous—are founded by some species in the normal manner, and by others, which are temporary social parasites, in one of the abnormal methods.

♀

1	Joints 2–5 of funiculus longer than the succeeding ones; frontal area distinctly defined	*Formica* L.
–	Joints 2–5 of funiculus not longer than the succeeding ones; frontal area not distinctly defined – – – – – – – – – – – – –	*Acanthomyops* Mayr.

♂

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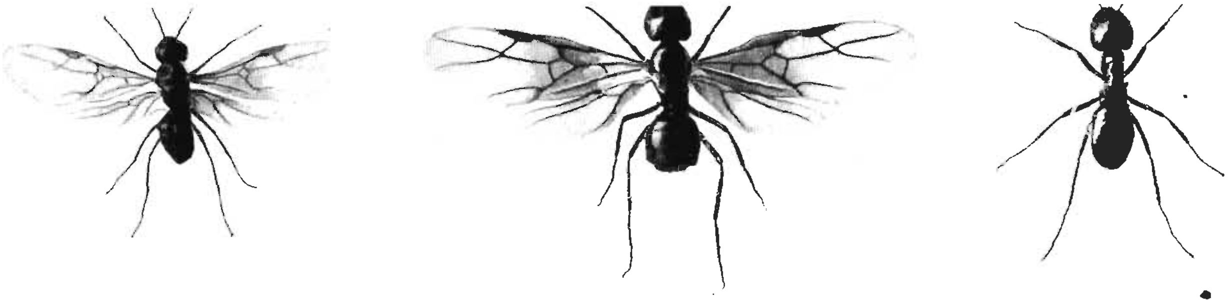
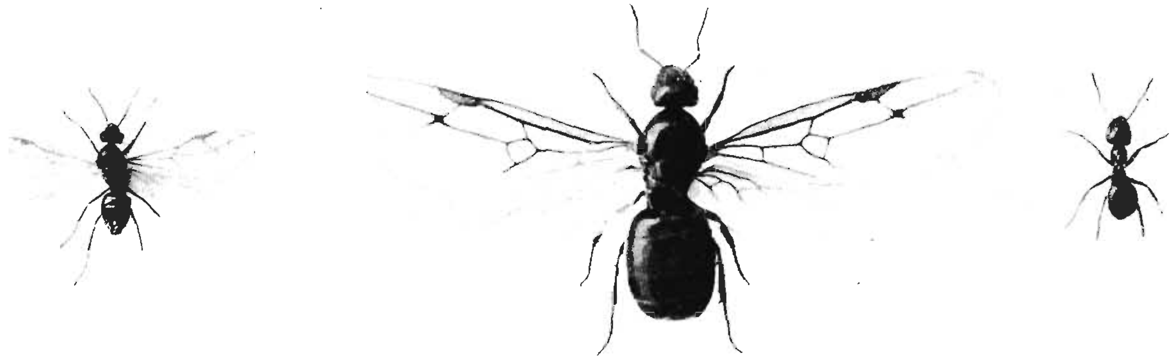


Male, female, and worker of *Acanthomyops fuliginosus.*



Male, female, and worker of *Acanthomyops alienus*

Face page 296.

The fertile females, whose gasters are often enormously swollen with eggs, are always surrounded by a court of workers, being sometimes entirely covered by them, and the latter continually follow their queen, feed and clean her, and carry away her eggs as she lays them.

Crawley and I have shown that the large-bodied females of this genus lay eggs only a few days after fecundation, whereas the temporary social parasites do not lay till the next year.

The males being about the size of the workers, and sometimes even smaller than the largest specimens of the latter, are considerably smaller than the females, and are usually carried by them in the air when united, during the marriage-flight.

Escherich states that the normal period for the marriage-flight is July, and that it extends from the middle of that month to the middle of August. But in England August is the principal time, and these marriage-flights sometimes commence as early as June and continue till October, swarms during the latter month being probably due to a second generation of the males and females.

The workers in some species are nearly all uniform as regards size, but in others both large and small specimens occur.

The larvae practically occur in the nests throughout the year, being always present in the winter, and they take considerably longer to develop than is the case with the larvae of *Formica.*

The workers feed the larvae with liquid food, but will also give them bits of dead insects, eggs, and other larvae, etc., to eat.

The pupae are generally enclosed in cocoons, and both André and Saunders state that this is always the case ; but F. Smith, Mayr, Forel, Janet, and I have all recorded instances where a number of naked pupae have occurred.

These ants are not so warlike, nor so quarrelsome as *Formica,* and generally act on the defensive, barricading their nests, and the entrances to their subterranean galleries, with grains of earth, when attacked ; but occasionally will pour out in vast multitudes, and overwhelm the foe by sheer weight of numbers.

Their method of fighting is for five or six workers to seize the legs of their adversary, and hold on.

Sometimes colonies of different species may be found together, nesting under the same stone, or in close proximity to each other, but it is only in cases where the mixed nest owes its origin to the abnormal method of colony founding that they are really associated. In other cases, where they are living together only by chance, when the nest is disturbed, or the different ants are put into a box, they will at once attack each other.

The method by which ants of this genus salute each other is very characteristic ; it has already been described by Crawley, and as far as is known to me he is the only myrmecologist who has published an account of this curious action.

When two specimens of *Acanthomyops* meet, one of the ants will be seen to make a succession of rapid jerks of the body towards the other, which lasts for several seconds. This motion does not consist in striking the head against the other ant, and the only parts of the body touching at the time are usually the antennae. On uncovering an artificial nest of *A. flavus* or *niger* and exposing it to the light, almost every ant may be seen thus jerking its whole body to its neighbours. An ant may be seen in an artificial nest to salute nearly every ant it meets. The workers greet young winged females and males in the same manner, and the females sometimes respond, but the males never do. I have seen young winged *A. umbratus* females frequently salute each other in this manner when they met. A young fertile female will respond to the salutes of her first brood, but an old female in a large nest never does so.

Fabricius [Syst. Piez. 415 (1804)] published a heterotypical genus *Lasius* for the reception of ten species of ants, but this use of the name is invalid since *Lasius* (Type *Apis quadrimaculata* Panz.) had already been used by Jurine for a genus of Bees [Erlangen Litt.-Ztg. **1** 164 No. 33 (1801) : Nouv. Méth. Hym. 235–238 No. 33 Pf. 4·33, 11·33 (1807)]. Latreille [Gen. Crust. Ins. 4 126 (1809)] sunk *Lasius* F., as a synonym of *Formica*, and the Fabrician name ceased to be used until 1861, when Mayr [Europ. Formicid. 49 (1861)] revived and re-characterized *Lasius* F., adopting *niger* L., F., as his type. Bingham [Faun. Brit. India. Hym. **2** 338 (1903)] and Wheeler [Ann. New York Acad. Sc. **21** 165 (1911)] also cite *niger* as the type. This species was also adopted as the Type by Morice and Durrant [Trans. Ent. Soc. Lond. **1914** 421–423 (1915)] who gave the following reasons for the change of name :—" In the Systema Piezatorum Fabricius made use of Jurine's name *Lasius*, but applied it to a genus of Ants which he separated from *Formica* L., and later authors have ignored Jurine's *Lasius*, no doubt because the publication of the Piezatorum (1804) antedates that of the Nouvelle Méthode (1807). But the real date of *Lasius* Jur., as we now learn, is May 30th, 1801 (Erlangen List)—§ *Lasius* F. (1804) therefore sinks as a homonym of the earlier *Lasius* Jur. A new name for § *Lasius* F. is necessary, there being apparently no existing synonym, we therefore propose that it be called *Donisthorpea* in recognition of Mr. H. St. J. K. Donisthorpe's careful investigations into the bionomics of this and other Heterogynous genera."

If one accepts Jurine's paper it is necessary (among other changes of nomenclature which are brought about) to find a new name for *Lasius* F. (1804), a genus of ants which sinks as a synonym of *Lasius* Jur. (1801), a genus of bees. This was done, as we have just seen, by Morice and Durrant, who proposed the name of *Donisthorpea*. At that time they considered *Acanthomyops* Mayr (1862),

to be a good genus, and not a subgenus of *Lasius* F., as it is usually regarded, and they were not aware of Ruzsky's subgenera *Dendrolasius* and *Chthonolasius* (1912).

Wheeler [Science (n.s.) **43** 316–318 (1916)], in a very generous and appreciative review of the first edition of "British Ants," stated that he was not prepared to accept Jurine's paper, and he also expressed the opinion that neither Forel nor Emery would do so. In this, however, he was mistaken, as both Forel and Emery did accept the Erlangen List. Forel [Rev. Suisse Zool. **24** 460 (1916)] substitutes Mayr's *Acanthomyops* for the genus *Lasius* F., but he incorrectly treats the subgenus *Donisthorpea* Mor. and Drnt. with type *nigra* L., as a synonym of *Chthonolasius* Ruzsky, with type *flavus* F.! He also states that he is prepared to accept the name *Formicina* instead of *Lasius*, if this will put an end to any further changes of names.

Emery (Acad. Sci. Ist. Bologna **1916** 61), on the other hand, selects *Formicina* Shuckard (1840), as a substitute for *Lasius* F., but the use of this name is invalid, as Wheeler [Ann. New York Acad. Sci. **21** 164 (1911)] fixed *Formica rufa* as the type of *Formicina*, and sunk it as a synonym of *Formica* L. (Emery also gives the dates of Ruzsky's subgenera as 1908, whereas they were published in 1912.) In the Genera Insectorum, Fascicule 183 (1925), however, he returns to the Fabrician name of *Lasius*.

If the validity of Jurine's paper be accepted the synonymy is as follows :—

Acanthomyops Mayr.

= § *Lasius* (nec. Jurine) F. (1804) ; =* *Formicina* (Shuck. p. 1840) : Forel and Emery (1916) : — nec. Wheeler (1911) ; =*Acanthomyops* Mayr (1862) ; =*Dendrolasius* Ruzsky (1912) ; =*Chthonolasius* Ruzsky (1912) ; =*Donisthorpea* Mor. and Drnt. (1915) ; =**Chthonolasius* (nec. Ruzsky), Forel (1916).

Type 1 : **Formica clavigera** Roger (**claviger** Mayr ; Mayr, 1862 ; Wheeler, 1911).

Acanthomyops Mayr Verh. Zool.-Bot. Ges. Wien **12** 699–700 (1862); Wheeler Ann. N.Y. Ac. Sc. **21** 157 (1911) ; Forel Rev. Suisse Zool. **24** 460 (1916).

Type 2 : **Formica fuliginosa** Ltr. (Ruzsky, 1912).

Dendrolasius Ruzsky Kasani Zap. Veterin. Inst. **29** 629–33 tf. 2 (1912); Forel Rev. Suisse Zool. **24** 460 (1916).

Type 3 : **Formica flava** L. (Ruzsky, 1912).

Chthonolasius Ruzsky Kasani Zap. Veterin. Inst. **29** 629–33 tf. 3 (1912). * *Formicina* Shuck. (p.) Lardner's Cab. Cycl. **10** (Hist. Nat.-Arr. Ins.) 172 (1840) ; Forel Rev. Suisse Zool. **24** 460 (1916) ; Emery Acad. Sci. Ist. Bologna **1916** 61.

[nec. *Formicina* Shuck. Lardner's Cab. Cycl. **10** (Hist. Nat.-Arr. Ins.) 172 (1840); Wheeler Science **33** 859 860 (2 VI 1911); Ann. N.Y. Ac. Sc. 21 164 (17 XI 1911)—Type : *rufa* L. (*Formica* L.).]

[nec. **Chthonolasius* (Ruzsky) Forel Rev. Suisse Zool. **24** 460 (1916)—Type : *nigra* L. (*Donisthorpea* Mor. and Drnt.).]

Type 4 : **Formica nigra** L. (Mor. and Drnt. 1915).

Donisthorpea Mor. and Drnt. =§ *Lasius* (nec. Jurine) F. Syst. Piez. pp. xi., 415–418 No. 78 sp. 1–10 Ind. 18 (1804); Auctt. . . . *Donisthorpea* Mor. and Drnt. Tr. Ent. Soc. Lond. **1914** 423 (1915). **Chthonolasius* (nec. Ruzsky) Forel Rev. Suisse Zool. **24** 460 (1916).

☿ *Head* cordate; *clypeus* broad, convex, rounded anteriorly, posterior border distinct; *frontal carinae* fairly short; *frontal area* indistinctly defined, broader than long, rounded posteriorly; *frontal furrow* indistinct or sometimes distinct; *mandibles* triangular, terminal border dentate; *maxillary palpi* six-jointed; *labial palpi* four-jointed; *antennae* twelve-jointed, *funiculus* with joints two to five not longer than the succeeding ones; *ocelli* indistinct. *Thorax* short; *pronotum* rounded, suture between pronotum and mesonotum distinct; *mesonotum* convex; *epinotum* short, with a flat, sloping surface posteriorly. *Petiole* with scale vertical, or slightly inclined forward; *gaster* oval, flatter than in *Formica*. *Legs* shorter than in *Formica*.

♀ *Head* as in the ☿; *ocelli* distinct. *Thorax* robust; *pronotum* short; *mesonotum* large, rounded and convex anteriorly, flat posteriorly; *scutellum* broad, very slightly convex; *epinotum* sloping, rounded posteriorly. *Wings: fore-wings* with one cubital cell, and one discoidal cell, the latter sometimes wanting. *Gaster* flatter than in *Formica*. *Legs* shorter than in *Formica*.

♂ *Head* triangular; *clypeus, frontal area* and *palpi* as in the ☿; *frontal carina* short, slightly divergent posteriorly; *mandibles* broad armed with a single tooth at apex, or with terminal border dentate; *antennae* thirteen-jointed, with the first joint of the *funiculus* broader, and the last joint longer than the rest. *Petiole*, with scale as in the ☿. *External genital organs* very small. *Wings* as in the ♀. *Size* generally much smaller than in the ♀.

Ovum : White, round oval.

Larva : Pale yellowish white, long, very narrow, and curved anteriorly, with the segments distinctly defined, and gradually increasing in breadth till just before the base. The whole body covered with short, slightly curved, yellow hairs of about equal length, which are more abundant in the younger larvae. The body appears to be finely striate transversely.

Pupa : Enclosed in pale reddish yellow cocoons, but sometimes naked.

Original description of *Lasius* F. [Fabricius Syst. Piez. 415 (1804)] :—

" **Lasius** Os absque lingua.
Mandibula brevis, fornicata, apice rotundata cum acumine.
Labium maxilla brevius.
Antennae medio frontis insertae, fractae."

Table of the Species.

☿

1 { Colour shining black . . . . 1 *fuliginosus* Latr.
– { Colour otherwise – 2
2 { Colour yellow 3
(1) { Colour brown or blackish brown – – – – – – – – – – – – – 5

3 Size variable, generally smaller; scale low, broadest at apex . 5 *flavus* F.
(2) Size less variable, larger ; scale higher, not broadest at apex – – – – – 4
(4) Funiculus thinner, with joints longer than broad ; tibiae with outstanding hairs . . . . 6 *umbratus* Nyl.
3 Funiculus thicker, with joints not longer than broad ; tibiae without outstanding hairs – 7 *mixtus* Nyl.
5 Scape of antennae and tibiae with outstanding hairs . . . . 2 *niger* L.
(2) Scape of antennae and tibiae without outstanding hairs – – – – – – – – 6
6 Frontal area indistinct . . . . 3 *alienus* Först.
(5) Frontal area well marked – – – – – – – – – – – – – – – – 4 *brunneus* Latr.

♀

1 Head large, as broad as thorax, emarginate posteriorly 2
– Head small, not as broad as thorax, not emarginate posteriorly – – – 4
2 Colour shining black . . . . *fuliginosus* Latr.
(1) Colour brown – 3
3 Funiculus thinner, with joints longer than broad ; tibiae with outstanding hairs . . . . *umbratus* Nyl.
(2) Funiculus thicker, with joints not longer than broad ; tibiae without outstanding hairs – *mixtus* Nyl.
4 Underside of head, thorax, and gaster yellowish . . . . . . *flavus* F.
(1) Underside the same colour as above – – – – – – – – – – – – – – – – – – – 5
5 Scape and tibiae with outstanding hairs . . . . *niger* L.
(4) Scape and tibiae without outstanding hairs – – – – – – – – – – – – – – – 6
6 Wings clear . . . . *alienus* Först.
(5) Wings smoky – *brunneus* Latr.

♂

1 Mandibles armed with five teeth 2
– Mandibles armed with a single tooth – – – – – – – – – – – – – – – – – – 3
2 Eyes with distinct outstanding hairs . . . . *umbratus* Nyl.
1 Eyes almost without hairs – – – – – – – – – – – – – – – – – – – *mixtus* Nyl.
3 Colour shining black ; gaster with large scattered punctures . . . . *fuliginosus* Latr.
(1) Colour otherwise ; gaster without large scattered punctures – – – – – 4
4 Frontal furrow indistinct ; wings slightly smoky . . . . . . *flavus* F.
(3) Frontal furrow distinct ; wings clear – – – – – – – – – – – – – – – – – 5
5 Scape and tibiae with outstanding hairs ; mandibles black brown *niger* L.
(4) Scape and tibiae without outstanding hairs – – – – – – – – – – – – – – – 6
6 Wings clear ; mandibles partly yellowish . . . . *alienus* Först.
(5) Wings smoky ; mandibles black-brown – – – – – – – – – – *brunneus* Latr.

Acanthomyops (Dendrolasius) fuliginosus Latr.

[“ The Jet Ant ” Gould Account English Ants 2[1] 9[2] 86–90[3] (1747).] *Formica fuliginosa* Latreille Ess. Hist. Fourmis France 36 (1798)[4]. (“ La fourmi fuligineuse ” Huber Mœurs Fourmis 52 318 Pf. 1·3–4 (1810))[5]. *Formica fuliginosa* Schenck Jahrb. Ver. Naturk. Nassau **8** 45–48[6] 139[7] (1852) ; Mayr Verh. Zool. Bot. Ver. Wien 284[8] 351[9] (1855) ; F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 97[10] 105–106[11] (1855) ; Haliday NH. Review **4** 33 (1857)[12] ; F. Smith Cat. Brit. Foss. Hym. 10 (1858)[13] ; Meinert Kong. Danske. Vidensk. Selsk. Skrift. **5** 320–321 (1861)[14]. *Lasius fuliginosus* Mayr Europ. Formicid. 49–51 (1861)[15]. *Formica fuliginosa* F. Smith Ent. Ann. **1866** 130[16] : **1868** 95[17] ; Holt Science Gossip 1868 159[18]. *Lasius fuliginosus* Forel Denkschr. Schweiz. Ges. Naturw. **26** 46[19] 181–187[20] 217[21] 375[22] 407[23] (1874) ; Lubbock Mo. Mic. Journ. **1877** 134 Pf. **190**·3[24] ; Saunders Trans. Ent. Soc. Lond. **1880**

208[25]; Er. André Spec. Hym. Europe 2 49-50 191 (1881)[26]. *Formica fuliginosa* Buckton Mon. Brit. Aphidae 4 86 (1883)[27]. *Lasius fuliginosus* Perkins Ent. Mo. Mag. **27** 195 (1891)[28]. *Formica fuliginosa* Douglas Ent. Mo. Mag. **28** 106 (1892)[29]. *Lasius fuliginosus* Dalla Torre Cat. Hym. **7** 185 (1893)[30]; D. Sharp Trans. Ent. Soc. Lond. **1893** 202[31]; Sulc Ent. Mo. Mag. **30** 87 (1894)[32]. *Formica* (*Lasius*) *fuliginosa* Farren-White Ants' Ways 234–235 (1895)[33]. *Lasius fuliginosus* Saunders Hym.-Acul. 23–24 (1896)[34]; Donisthorpe Ent. Rec. **9** 246 (1897)[35]; Rothney Ent. Mo. Mag. **35** 14 (1899)[36]; Morley Hym. Suffolk **1** 1 (1899)[37]; D. Sharp Camb. NH. Ins. **2** 138[38] 153[39] (1899); Wasmann Zool. Anzeig. **22** 85–87 (1899)[40]; Lagerheim Ent. Tidskr. **21** 17–29 (1900)[41]; Oudemans Allgem. Zeitschr. Ent. **6** 179 (1901)[42]; Vic. Hist. Durham **1** 95 (1905)[43]; Escherich Ameise 94[44] 112[45] (1906); de Lanoy Ann. Soc. Ent. Belg. **52** 47–53 (1908)[46]; Forel Ann. Soc. Ent. Belg. **52** 180 (1908)[47]; Emery Ann. Soc. Ent. Belg. **52** 182 (1908)[48]; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 224 (1908)[49]; Wasmann Zool. Anzeig. **35** 135 (1909)[50]; Wheeler Biol. Bull. **19** 134 (1910)[51]; Donisthorpe Ent. Rec. **22** 17 (1910)[52]; Crawley Ent. Record **22** 67 (1910)[53]; Donisthorpe Trans. Ent. Soc. Lond. **1911** 180–181[54]: Entom. **44** 390 (1911)[55]; Donisthorpe and Crawley Trans. Ent. Soc. Lond. **1911** 664–672[56]; Donisthorpe Ent. Rec. **24** 6 (1912)[57]; Zimmer Zeit. Wiss. Insektenbiol. **8** 32 (1912)[58]; Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 51–55 (1913)[59]; Donisthorpe Rep. Lancs-Chesh. Ent. Soc. **36** 1912 40 (1913)[60]: Ent. Rec. **26** 39 (1914)[61]; J. B. Elliott Trans. Brit. Mycol. Soc. **1914** 138–139[62]; Schmitz Jaar. Natuur. Genoots Limburg **1915** 76[63]. *Formecina* (*Dendrolasius*) *fuliginosa* Emery Bull. Soc. Ent. Italiana **47** 240 (1916)[64]. *Donisthorpea fuliginosa* Donisthorpe Ent. Rec. **28** 2–3 (1916)[65]. *Acanthomyops* (*Dendrolasius*) *fuliginosus* Donisthorpe Ent. Rec. **29** 32–33 (1917)[66]: **30** 23 (1918)[67]: **31** 3 (1919)[68]. *Lasius fuliginosus* Stumper Arch. Naturgesch. **85** 189 (1919)[69]. *Lasius* (*Dendrolasius*) *fuliginosus* Wheeler Bull. Mus. Compar. Zool. **64** 543 (1921)[70]. *Dendrolasius fuliginosus* Lomnicki Ent. Anzeig. **2** 79–80 (1922)[71]. *Acanthomyops* (*Dendrolasius*) *fuliginosus* Donisthorpe Ent. Rec. **34** 21 (1922)[72]. *Lasius fuliginosus* Laing Ent. Mo. Mag. **59** 245 (1923)[73]. Hallett Cardiff Nat. Soc. **52** 53 1919 (1923)[74]; Wasmann Att. Pont. Accad. Romana **76** 255–259 (1923)[75]. *Acanthomyops* (*Dendrolasius*) *fuliginosus* Donisthorpe Ent. Rec. **35** 3 (1923)[76]: **36** 50 (1924)[77]: **37** 4–5 (1925)[78]. *Lasius* (*Dendrolasius*) *fuliginosus* Emery Gen. Ins. **183** 236 (1925)[79].

☿ *Jet black, shining, funiculus and tarsi yellowish brown, mandibles, scape femora and tibiae reddish brown. The whole body finely alutaceous, and sparsely covered with fine pubescence.*

Head large cordiform, emarginate posteriorly; *ocelli* very small but distinct. *Epinotum* broad. *Scale* high, narrowest at apex. *Long.* 4–6 mm.

♀ *Colour and puncturation the same as in the worker ; more pubescent, with short erect hairs.*

Head large, as broad as thorax, cordiform slightly more strongly emarginate posteriorly than in the ☿. *Wings* with the anterior half blackish. *Long.* 6–6·5 mm. (6–8 mm. *teste André.*)

♂ *Colour as in the ♀, less pubescent, but puncturation more distinct.*

Head finely rugose, widely emarginate posteriorly; *mandibles* furnished with one large tooth at apex. *Mesonotum* and *gaster* with large scattered punctures. *Wings* as in the ♀. *Long.* 4·5–5 mm.

Original description of *Formica fuliginosa* Latreille [Ess. Hist. Fourmis France 36 (1798)] :—

" * F. fuligineuse, *fuliginosa*.

O. p. Courte, très-noire, luisante. Antennes, à prendre du coude, genoux et tarses, d'un brun testacé. Tête grosse, échancrée postérieurement. Ecaille

petite. Abdomen globuleux. *Mâle*, Couleurs semblables. Écaille entière, presque ovée. Aîles antérieures obscures à leur base. *Femelle*. Très-noire, courte. Mandibules, antennes et pattes roussâtres. Aîles et écaille du mâle."

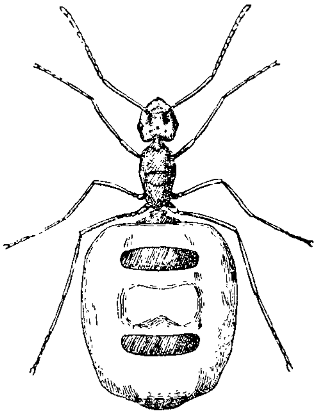


Fig. 83. *Acanthomyops fuliginosus* ♀ with gaster distended with eggs.

Habitat.

Acanthomyops fuliginosus ranges over the greater part of Europe ; Ruzsky records it from the Caucasus, Siberia, and Finland, Bingham from Thana in Western India ; Wheeler records it from Hong-Kong in Southern China[70], and it is found in Japan, but Forel considers the Japanese form to be a variety and has recently named it var. *nipponensis*.

In England it is generally distributed as far north as South Lancashire, and South-West Yorkshire, but I have no records for South Wiltshire, Bedfordshire, Huntingdonshire, East Gloucestershire, Monmouth, Shropshire, or South Lincolnshire. It has been recorded as " not common " in Durham[43], but I am very doubtful about this, as Bagnall who has collected so much in that county and has also hunted for ants' nests, has never come across it ; moreover, there are no records for Cumberland, Westmorland, nor the greater part of Yorkshire. Buckton's record of *Aphidae* in nests of this species " on the moors round Alnwick and near Wooler in Northumberland "[27] is exceedingly doubtful, as *A. fuliginosus* does not harbour " Plant-Lice " in its nests, and the moors are not a likely locality for it—he must have referred to nests of *Formica fusca*.

It does not occur in Scotland, while from Wales I have records only from Glamorgan, Carnarvon, and Denbigh, and Ireland from Dublin, Wicklow, Carlow, Waterford, and South Cork.

The most northern locality in which it has yet been found, for certain, in the British Isles, is the Isle of Man, where I discovered it in a turnip-field, near Colby Glen, on September 30th, 1923. The species must have been nesting in the ground, as there were no trees near. The Isle of Man was covered with a vast sheet of ice during the Glacial epoch, but it is unknown whether it was connected with England or Ireland after the disappearance of the ice, or whether it was isolated before that period. I do not believe in the fortuitous arrival of this ant, either by air, water or human agency. New colonies, as we shall see later, are founded by branch nests, by the return of fecundated females to nests of their own colonies after the marriage-flight, or by such females being accepted into nests of *A.* (*C.*) *umbratus*, or *A.* (*C.*) *mixtus*. The marriage-flight takes place on, or near, the parent nest ; the female does not fly strongly, and gets rid of her wings at once after being fertilized. It is very doubtful if she could be carried so far at the Isle of Man by the wind ; the nearest land being Scotland, sixteen and twenty miles, Cumberland thirty miles, County Down, thirty miles, and Anglesea, forty-five miles. Even if she were, it is extremely improbable that such a female, which is unable to found her colony unaided, would find a nest of *umbratus* or *mixtus*, if they occur on the island, which is not known to be the case at present. Secondly, if by water, she would surely perish before she reached the island ; and it is also very improbable that the carton nest of this species could be drifted over without all the inhabitants being drowned. I am therefore of opinion that the presence of this ant on the Isle of Man showed that it (the island) had been joined on to the mainland, and not been isolated, until after the ice of the Glacial period had disappeared[77].

Acanthomyops fuliginosus can be easily recognized by its habits, odour, and nests, and is often abundant where it occurs. It nests in woods, in groups of trees, but also in isolated ones, and may be seen marching steadily along, in long files, on beaten tracks. As long ago as 1747 our countryman Gould described this habit in the following quaint language[3]:—" There remains a particular Curiosity to be mentioned with regard to the Jet Ants, which not only deserves Admiration, but strongly tends to illustrate the preceding Observations, and to show that Man is not the only Partaker of Wisdom. It is remarkable of these Ants, that in carrying on their Employments they Form so many Streets or different Tracts as are proportionable to the Size and Situation of their Colonies. If the Inhabitants be very numerous, as it usually happens in this Species, they extend their Streets to a considerable Length, (Forty Yards or more) and the Number of them shall amount perhaps to four, besides several less Branches that strike off from the main Tracts. Sometimes there is but one, sometimes two or more grand Streets, besides the little Allies, all which

frequently vary in Length. In these Paths the Workers continually make their Progresses to and from the Colony. And you may, with equal Pleasure and Certainty, observe the Variety of their Provisions, their Sedulity in seeking, and Method of bringing it Home. The Tracts are every Moment thronged with Multitudes of industrious Ants ; we may (to compare little things with great) not improperly resemble them to the busy Concourse in the Streets of *London*,—a regular Confusion. Only with this Difference, that not a single Ant is unemployed, or deserves the Title of a Vagrant. All are engaged for the Public Emolument, without Envy, without Complaint. No other Strife, but who shall first return laden with Provisions to sustain the Young. A laudable Emulation ! They exert their Labours at the earliest Appearance of Spring, and continue them so long as the Smiles of *Autumn* give leave. Nothing but Severity of Weather interrupts their Processions. Amongst the many Curiosities this Scene affords us, the Opportunity we have of viewing their Diversity of Aliment is not the least. Numbers of them come Home either with the Spoils of Insects, or the Insects themselves. But far the greatest Part are distended with Juice. I never could discern any fatiguing themselves with the Carriage of Wheat or other Grain ; and how such a constant Delusion should arise, if they delighted in Corn, is not easy to conjecture. Their Manner of collecting Provisions is likewise a pleasing Amusement. Their Settlements are generally placed in the Bottom of a Tree somewhat decayed, and in whose Neighbourhood are other Trees more flourishing and verdant. Sometimes the Jet Ants prefer residing in a Garden Wall replenished with Fruit. The Tracts are so contrived as to pass along by such Trees as promise the most Nourishment. The Labourers make Excursions from their main Paths to the Trees, and having gathered what Forage they can meet with, return the same Way they came. In order to facilitate their Progress, they remove any Obstacles that lie in their Road, as Bits of Straw, Sticks, and other Rubbish ; and also Bite off the Herbs almost even with the Surface of the Ground. Thus by their indefatigable Pains they suffer not the Grass to grow in the Streets."

This ant possesses a very characteristic pungent, aromatic odour, which is not unpleasant, though Gould[2] says—" It may be remarked that the Jet Ants have a peculiar disagreeable Smell, which, I fancy, is a great Preservative to them against an Enemy " —and Farren-White[33] describes it as a fragrant scent like that of the musk beetle, but it does not remind me of the odour of that insect.

Forel gives reasons to show that the seat of this odour lies in the head more than in any other part of the body[22], as the heads, when crushed, give off a very violent odour, though the thorax and gaster do not seem to be entirely inodorous.

Landois described a structure in these ants by means of which they can probably stridulate, though Sharp[31] does not consider it to be a true stridulating organ. It consists of delicate transverse lines sculptured on the dorsal surface in the middle at the base of the third gastric segment, the line of demarcation between the general sculpture and that of the basal portion not being very abrupt. There is, however, no special contrivance on the overlapping segment to scrape against it, but the friction of the segments together probably produces some sound.

The colonies of *A. fuliginosus* are often very populous, and a number of subsidiary nests may occur in neighbouring trees. Rothney found the nests of this ant were extremely abundant in old oak trees at Barham, and two such trees were situated on the opposite sides of a gravel pathway, beneath which the ants had excavated a tunnel of communication[17]. Consequently they are able to overpower any other ants in the neighbourhood, as they can concentrate in vast numbers very quickly at any desired spot. Forel[22] placed the contents of ten nests of *Formica pratensis* near a tree occupied by *A. fuliginosus*, and the latter when besieged obtained assistance from the inhabitants of other trees near, overwhelmed the *pratensis* with their numbers and captured all their cocoons. Wasmann[40], in 1884, emptied a sack full of *F. rufa* at the entrance to the nest of a strong colony of *A. fuliginosus* in a garden at Exaeten, when the latter swarmed out and drove off the former.

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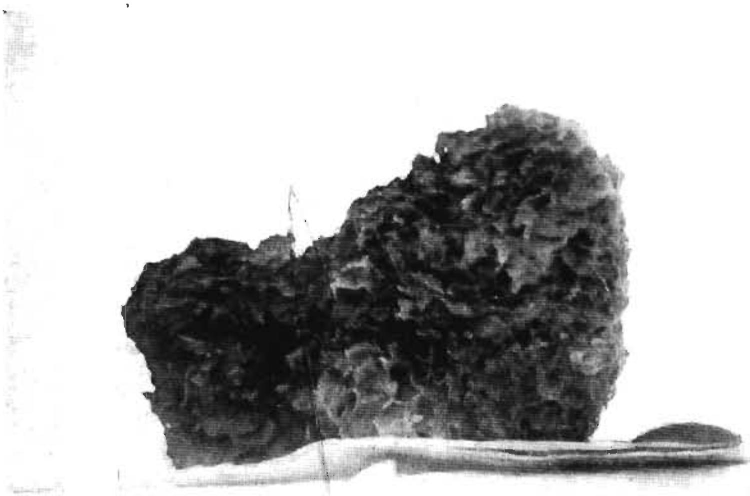
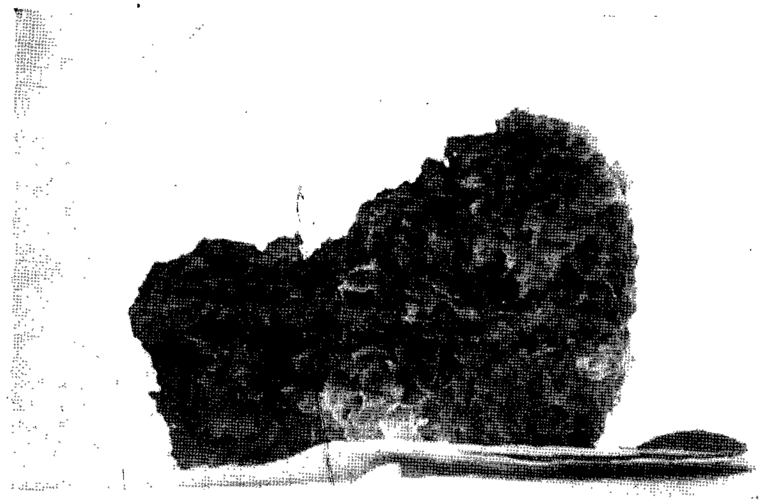


Carton nest of *Acanthomyops fuliginosus*.
Dug up at Oxshott, 9.IX.13.

Acanthomyops flavus mounds. Oddington, 18.IV.14.

Face page 216



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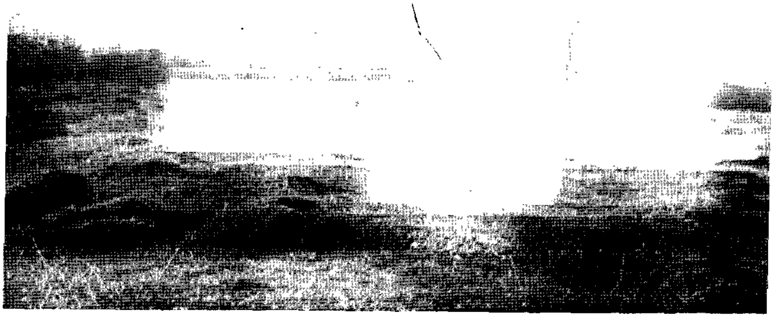


Acanthomyops flavus mounds. Oddington, 18.IV.14.

Huber[5] and other old writers thought the nests of this species were excavated in wood which was stained black by the ants' acid, but Meinert[14] and then Forel[20] proved this not to be the case.

They are really made of carton, consisting of chewed fragments of wood and bark, mixed with earth and cemented together with the secretion from the mandibulary glands, which are greatly developed in this ant (see Fig. 42). Forel[20] suggests that the liquid from the metathoracic glands helps to soften the wood which the ants chew up ; but that of the salivary glands seems more likely for this purpose.

These nests are often very large, having the appearance of a huge sponge, and consist of a number of irregular cells separated from each other by thin carton walls, which are rather brittle and generally black in colour, but sometimes light brown, according to the amount and the colour of the earth used in their construction —the carton of a nest I found in the Isle of Wight was of a light reddish brown colour. The carton contains a quantity of a fungus which was named *Septosporium myrmecophilum* by Fresenius, Saccardo describes it as *Macrosporium myrmecophilum*, but considered it might be identical with *Cladotrichum*, and Lagerheim came to the conclusion that it was really a *Cladotrichum* and called it *C. myrmecophilum*[41]. (I supplied Dr. Jessie Baylis Elliott of the Birmingham University with various samples of *A. fuliginosus* carton, and she has proved, by making cultures, etc., that the fungus it contains is a *Cladosporium*, and so should be called *Cladosporium myrmecophilum*[62].) The " raison d'être " of this fungus is probably twofold, the hyphae may act as food for the ants and their brood—it forms a delicate bluish mould on the walls of the cells, and under the microscope it may be seen to have been bitten off by the ants—and the mycelium helps to strengthen the walls of the nest. The ants most probably cultivate this fungus intentionally, as no other species of fungus is found in these nests, but it would not alone supply sufficient food for the teeming myriads that go to form the population of a large colony.

Dr. Sharp says this species lives in decayed wood[38], but though its nests are generally built in hollow trees, old tree stumps, and posts, they frequently occur in the ground, at the roots of, but also away from, trees, and even in houses and cellars, etc.

On September 9th, 1913, I dug up a nest at Oxshott which was thirteen inches long, nine and a half inches high, and eight and a half inches broad, and was situated under the roots of a large Scots fir some three feet below the surface of the ground. The earth surrounding the nest was of a soft sandy nature, but just below it the ants had excavated small chambers in the ground, and the soil round these was almost as hard as stone.

Smith records it as nesting in a sand-bank at Southend[11] ; near

Combe Martin, in the mud walls by the roadside[16]; near Ilfracombe he observed it inhabiting fissures in the rocks[16]; Farren-White[33] speaks of it as a miner at Clevedon and White Notley; Perkins[28] found an enormous colony in a sandy bank at Wotton-under-Edge in 1891; and Rothney[36] mentions its occurrence in an earth bank on the Headland at Newquay in 1899.

In August, 1914, I observed a number of *A. fuliginosus* workers attending large black *Aphidae* on some young birch trees on Weybridge Heath. It was almost impossible to discover whence they came, but eventually I found the ants had constructed a tunnel, about an inch in diameter, just beneath the surface of the ground. This tunnel extended for six yards, when it entered a sandy bank, and deep in this bank their large carton nest was situated.

Haliday found this *Acanthomyops* on an undulating expanse of bleached sand off Arklow Head in August, 1856; he says the ants were far away from any trees, but seemed quite busy and happy in the torrid heat[12].

I have also seen it nesting in the sand near the sea; the colony in question was situated in a hollow in the sand-dunes at Southport[49], no trees occurred anywhere near, and the ants entered and left their nest by a hole in the sand.

Schenck[6] records the occurrence of two nests in the hollow wall of a Garden-house near Homburg, which he says were made of bits of wood and plants, and little stones all fastened together. The one measured two feet in height, two feet in breadth, and half a foot in thickness, and the other was of the same height and thickness, but was only one foot and a half broad. He says a gardener had known of the existence of the ants in this house for about thirty or forty years, and he also mentions another nest in the straw roof of an ice-house.

Holt[18] in 1868 saw a nest in the floor of a house at Upper Norwood which was built between two of the joists and rested on the ceiling of the cellar below. He says the ants passed in and out of the house under the doorstep and the nest seemed to be composed of masticated wood. Crawley[53] knew of a similar nest in the beams of the cellar in a house he lived in, W. E. Sharp showed me a grating in the wall of his house at Crowthorne where these ants gained access to his cellar, and Nevinson told me a colony had established itself under the concrete floor of a lavatory in his house at Cobham—he has recently had the floor taken up, and he found a nest one foot four inches high, by one foot six inches wide. He showed me the remains of this nest, and the place whence it came, and he assures me that though the ants had lived in his house for some years, they merely took exercise in the hall without hunting for food and they never went out of doors at all. This being the case it would seem that the fungus cultivated by the ants is

sufficient to sustain the colony! Also, as will be seen presently, the great difficulty experienced in rearing *fuliginosus* larvae in captivity—when no carton is present—would seem to show that the fungus is necessary as food, though the ants feed on other substances as well. These remarks will apply in part to *A. umbratus* also.

Oudemans[42] has described and figured a nest he found in 1885 in the roof of an ice-shed in Holland which measured thirty-seven centimetres in height, thirty-six centimetres in breadth and twenty centimetres in depth, and Zimmer[58] records the discovery of a nest which was situated in a child's coffin which had been buried for about thirty years, the entire interior of the coffin being filled with the carton made by the ants.

A. fuliginosus often deserts its nests, especially when they have been disturbed, but, on the other hand, it often remains in the same place for long periods. Bennett has known of a colony, nesting at the foot of a large oak tree at Guestling, for over twenty years.

The food of this ant consists very largely of the excreta of *Aphidae* which it attends on trees, though it does not harbour them in its nests, and it also visits *Coccidae,* hunts insects, feeds on the frass of caterpillars, collects seeds, and raids the nests of other ants, carrying off their pupae.

Forel[22] says they attend plant-lice on large trees, especially oaks, and Escherich states they only visit the *Aphidae* that live on the bark of trees[45].

A rare Aphid which appears to be always attended by this ant is *Stomaphis quercus* L. On September 22nd, 1921, specimens on the trunk of an oak tree at Woking were observed in crevices and partly under the bark; my attention was called to them by the clusters of *A. fuliginosus* workers which were attending them[72]. The same thing occurred on October 7th, 1921, and July 29th, 1925, at this tree; and on July 18th, 1923, at Wimbledon Common[73], and July 16th, 1924, at Tubney[78]. Though *fuliginosus* does not actually harbour Aphids in its nest, I have found *Schizoneura corni* F. in the close vicinity of the same.

Schenck[6] noticed that this species was very fond of a juice it obtained from a *Coccus* on oak trees, Douglas[29] recorded that Dr. Chapman observed it attending *Lecanium rubi* on bramble stems near Hereford, I found it visiting *L. persicae* on brambles in the New Forest on July 18th, 1918, and Sulc[32] found three females of *Pseudococcus aceris* on detached pieces of bark in the runs of *A. fuliginosus* at Prague, which were surrounded and caressed by the ants.

Morley[37] records it devouring the larvae of *Liparis salicis,* and carrying *Hemerobius stigma* in its jaws, and I have frequently watched the workers returning home laden with small insects,

though by far the greater number have nothing in their jaws, but their gasters are distended with liquid.

Forel[22] saw a number of these ants returning home, each with a pupa of a *Myrmica* in its mandibles, and he concluded they must have raided a large *Myrmica* nest, and Wasmann[40] observed on August 7th, 1898, at Lippspringe a strong colony of *A. fuliginosus* marching over a distance of twenty metres to a nest of *M. laevinodis*, and plundering and carrying home the larvae and pupae of the latter.

In spite of the fact that Gould never saw these ants carrying grain, they do most certainly collect the seeds of plants. Lagerheim has seen them carrying the seeds of *Viola odorata*, *V. hirta*, and *Melica uniflora* in Scandinavia[41], and in September, 1909, at Darenth Wood I collected a number of the seeds of *Melica uniflora* which I took from the workers of a colony of *A. fuliginosus*, as they brought them to their nest, which was situated in a large tree stump[52]. These seeds all belong to types which are attractive to ants, by reason of the food stored in them.

The marriage-flight takes place in the early afternoon, but also, according to Huber[5], in the middle of the night, which accounts for the fact that Morely took males at electric light in Ipswich[37].

Saunders[34] gives July and August as the months for the swarming of this species, but it also occurs both earlier and later in the year; Schenck[7] noticed a marriage-flight on June 25th, 1852, at Nassau, and Morley observed males and females swarming on spruce on May 4th, 1907, at Elvedon in Suffolk. Forel records the copulation on June 24th and 29th and July 3rd in Switzerland[23], and on July 27th, 1911, I observed at Wellington College, in the afternoon, a number of males and females running up the young shoots and boughs growing on a tree stump in which their nest was situated, and copulation took place on these branches[57]. In the case of the large nest before mentioned, which I brought home from Oxshott, copulation took place in September on the top of the nest and in the box in which it was placed. It will thus be seen that females are often fertilized by their brothers from the same nest, and as the male—unlike the other species in the genus—is not much smaller than the female, the latter is probably unable to carry the former during the marriage-flight.

The gaster in the fertile female in time becomes distended with eggs and swells enormously, having the appearance of a large sack of white membrane. On August 16th, 1913, I found such a one at Apse Heath in the Isle of Wight; she was lodged in the cells at the top of the carton nest, which was situated just below the turf at the foot of an oak tree, and was surrounded by a large court of workers[61]. Her total length is eleven mm., the gaster alone measuring seven mm. in length and six mm. in breadth. On May 7th, 1916, I found such another distended female at Woking in a colony which

had been established for some years in a decayed gate-post. Very little carton occurred, it only being present round the bottom of the post underground, and in a few cracks in the wood. The wood in the centre of the post was not decayed, but was tunnelled by numerous borings and cracks, and here the bulk of the ants and their larvae was housed. A queen with very distended gaster was found in a small hollow under a knot in the centre of the post, surrounded by a large court of workers. A number of privet petals was found in and around the post, and Morice (in whose garden the gate-post occurred) told me he had often observed the ants carrying these fallen petals towards their nest and taking them down the holes and cracks round the bottom of the post. It is difficult to suggest the reason for this, unless these petals are used in some way in the construction of carton.

It is probable that this colony was originally founded in a nest of *A.* (*C.*) *umbratus*, as some of the myrmecophiles present (the Acari *Trachyuropoda bostocki* and *Urodiscella philoctena*) are the normal guests of *umbratus*[66].

Crawley and I have shown that the female does not lay till the year after impregnation, and we have proved her to be a temporary social parasite[56], as will shortly be seen.

The larvae, which are very numerous, occur throughout the year, and the pupae are generally enclosed in cocoons, but both Mayr[8] and F. Smith[10] record finding a number of naked pupae.

A. fuliginosus often founds new colonies by branch nests, which accounts for the fact that many colonies are found in the districts where this ant occurs. After the marriage-flight newly fertilized females are received back into the parent and other *fuliginosus* nests near by. Occasionally, however, deälated females are found wandering about in localities some distance from their nests. Forel records finding a number of deälated females on roads at Soleure on July 21st, 1869[23], and Crawley found one at Oddington near Oxford, about one hundred yards from a nest, and others at Esher in August, 1899[59], and on July 31st, 1922, I picked up a winged female on a road at Barkham, no nest nor workers being found anywhere near by. She got rid of her wings when placed in a box, and died in two days after she had been taken home, although she had been fixed up in a small damp plaster observation-nest[76]. In such cases as these the females would not be likely to be received back into their own nests. However, when isolated they display no desire to found a colony. Crawley and I have both kept in captivity newly fertilized females which get rid of their wings immediately after impregnation ;—and they never settle down, but endeavour to escape, and soon perish.

Therefore, from the above facts alone, it seems doubtful whether the female of this species can found a colony unaided.

But further observations in the field point to *Acanthomyops*

umbratus and *A. mixtus* as the host-species of *A. fuliginosus.* In 1897 I found at Lymington a large colony of *A. fuliginosus* in a hollow tree, and *A. umbratus* was undoubtedly living with it, as workers of both species were going in and out of the same holes[35]. Crawley in 1898 repeatedly found workers of *A. umbratus* walking unmolested with the workers of a large nest of *A. fuliginosus* established under his house near Oxford[53]. In September, 1900, Tuck sent to me a worker of *A. umbratus* taken in a nest of *A. fuliginosus* at Bury St. Edmunds[54].

In 1904 de Lannoy[46] found at Knocke-sur-Mer a few workers of *A. mixtus* in the midst of a large colony of *A. fuliginosus* which were on good terms with the workers of the latter, and in 1906 he again found workers of *A. mixtus* in several *A. fuliginosus* nests. Forel[47], Emery[48], Wasmann[50], Wheeler[51], and I[54] commented on de Lannoy's observations, and expressed the opinion that the presence of these *A. mixtus* workers was due to the fact that fertile *A. fuliginosus* females had entered nests of the former species and been accepted. The queens of the *A. mixtus* had then died, or had been killed, either by their own workers, or by the *A. fuliginosus* females, and the offspring of the latter were reared by the *A. mixtus* workers. In the course of time many of the latter had died off, and the few found in the nests were the survivors of the original *A. mixtus* colonies.

Crawley and I determined to test this hypothesis by experiments on captive colonies. In July, 1910, a portion of a nest of *A. fuliginosus* was dug up at Darenth Wood containing a quantity of workers, larvae, males, and winged females, but no queen. The ants and brood were divided into two equal portions and each established in a four-chambered "Janet" nest. (It may be here mentioned that this ant cannot be kept in close confinement, but that if an observation-nest be connected by long glass or india-rubber tubes to another plaster nest, or glass bowl, or some other contrivance in which their food is placed, the ants will thus obtain sufficient exercise.) During July all the males died and most of the females, with the exception of about twelve, which were found to be deälated. As some of these latter subsequently laid eggs, from which larvae were reared, it is highly probable that mating had taken place inside the nest.

In the beginning of December, 1910, a nest of *A. umbratus* without a queen was obtained at Weybridge and divided into two equal portions, which were established in "Janet" nests.

The first experiment was made on December 10th when one of the deälated female *fuliginosus* was placed in the light chamber of one of the *umbratus* nests. She immediately entered the most crowded chamber ; one worker saluted her and another dragged her further in by a mandible, but eventually she was attacked and killed before evening. On December 13th another deälated female

was put into a small plaster nest with some of the workers from the same *umbratus* nest as in the former experiment. She was slightly attacked but made no resistance, and endeavoured to conciliate her assailants by stroking them with her antennae. When a worker endeavours to bite at the waist of one of these females, she protects it by crossing her hind legs over her back, and when at the neck, by pressing her head back close against the thorax. A few more workers were added, and on December 20th she was introduced with the workers into the *umbratus* nest. She was a little attacked by workers who had not seen her before, but the old workers protected her, getting between her and the others, and pulling them away by the leg, but very soon all hostility ceased, and she was evidently accepted. Many workers surrounded her, caressed and fed her, and all went well till April, when, a number of the workers having died off, some four hundred more were obtained from the Weybridge nest and introduced. These new-comers attacked the queen, though they were quite friendly with their sister workers, and as they persistently refused to accept her, she was removed and returned to her own nest on April 21st. The *fuliginosus* workers were very excited at her appearance in their nest, and she was much pulled about, but eventually lost sight of among the crowds of ants. On July 23rd a female with her gaster enormously dilated was noticed in the *fuliginosus* nest, with a large pile of eggs and surrounded by workers, which may possibly have been the female of the above experiment.

In the next experiment a female *fuliginosus* was still more easily received into the other *umbratus* nest, and by December 16th she was completely accepted. On March 22nd, 1911, another *fuliginosus* was introduced into this nest and was immediately accepted without any hostility whatever, as was the case with two more which were introduced in April, but subsequently removed. The two queens first introduced in this experiment began to lay on May 17th, 1911, for the first time, and these eggs hatched on August 9th. In 1912 they began to lay on June 29th, and laid more eggs than during the previous year, but nothing came of these. Some of the larvae which hatched in August, 1911, were nearly full grown in the summer of 1912, but they remained in this condition until 1914. A larva first pupated on June 23rd, 1914, and several more subsequently, but none of them reached the perfect state. As these were from eggs laid in May, 1911, it will be seen that they took over three years to develop as far as the pupal stage !

In 1913 I made a similar experiment with a nest of *Acanthomyops mixto-umbratus* obtained at Weybridge on August 11th, 1912, and subsequently strengthened with workers of *A. umbratus* from Wellington College. On September 14th, 1913, two fertilized females, from the Oxshott nest before mentioned, which had just removed their wings, were introduced into the *mixto-umbratus* nest, when

they were very little attacked and completely accepted the same day. The one died on October 12th, but the other has been treated by the workers as their queen, having been fed, cleaned, and caressed by them, and was still alive in this nest in 1915—she laid her first eggs on July 12th, 1914. She died on August 29th, 1915. The workers in this nest had all gradually died off,* and a large number of fresh *umbratus* workers was obtained from Woking and put into this nest. These accepted the old *fuliginosus* female at once. She was very weak and died a few days afterwards, but not from injuries. The workers had never shown any animosity toward her, treating her from the first as their queen.

Having been left with the above-mentioned queenless *umbratus* nest, I obtained a number of virgin *fuliginosus* females from a colony of that ant nesting in the ground under a broom bush at Weybridge. On September 3rd, 1915, I removed the wings from one of these females and introduced her into the observation-nest containing the *umbratus* workers. She ran about among the *umbratus* workers, tapping them with her antennae; she was not attacked and soon gained the last (dark, damp) chamber of the nest, which contained the bulk of the *umbratus*. She appeared to have been accepted at once and was saluted, cleaned, and fed by some of the workers. She was treated as their queen, and was not attacked until September 7th, when, the nest having been left in the sun, some of the workers began to attack her and pull her about. The nest was placed in a cool dark place, and by September 17th she was once more thoroughly accepted as queen; she was not attacked again, and on December 19th she was surrounded by a large court of attendant ants. Wheeler first demonstrated that if the wings be removed from a virgin *Formica* female it causes her to behave as would a fertilized one. I have subsequently found this to be the case in all such experiments with *Formica* females. In the genus *Acanthomyops*, Crawley has recorded that the act of removing the wings from virgin *umbratus* females was far from arousing the instincts possessed by a fertilized queen. In the above-mentioned experiment with a virgin female of *fuliginosus*, however, the effect caused by removing the wings was to make her act undoubtedly as would a fertilized queen.

On April 22nd, 1916, her gaster had commenced to swell, and on May 25th she laid a few eggs. On June 9th a larger packet of eggs was present, held up in one mass by several of the *umbratus* workers. On June 25th two larvae had hatched, the eggs having taken over

* A specimen of the beetle *Amphotis marginata* was introduced into this *umbratus* nest on August 23rd, 1914. When all the old *umbratus* workers had died by August 26th, 1915, and only the *fuliginosus* female and the *Amphotis* were left alive, the beetle and the ant were observed tapping antennae and, apparently vainly, mutually asking each other to be fed. This beetle was frequently fed by the old workers. It was introduced into the new nest, and settled down at once, living in this nest for nearly two years.

two months to develop. The eggs continued to hatch very slowly, and on November 28th some fifteen small larvae were present. On January 28th, 1917, ten medium-sized larvae were counted, and the *fuliginosus* female was surrounded by a number of *umbratus* workers. On May 1st, 1917, a fresh packet of eggs had been laid and the gaster of the female was considerably swollen. On May 22nd there were present over 200 *umbratus* workers, the *fuliginosus* female, one packet of eggs, and nine full-grown larvae. May 24th some of the *umbratus* workers were covering the larvae with bits of plaster, etc., to help them to spin their cocoons. Unfortunately during my absence in June and July the nest was allowed to get too dry, and on my return I found the eggs, larvae, and pupae had disappeared, and most of the *umbratus* workers died. On August 18th a number of *A.* (*D.*) *niger* worker cocoons from Woking was introduced, and these were collected by the few remaining *umbratus* workers. The workers from the *niger* cocoons began to appear on August 26th, and by October 13th all had emerged and were surrounding the *fuliginosus* queen. A number of fresh *umbratus* workers was brought home from Weybridge on October 16th, and a few at a time were introduced into the nest to strengthen the colony. At first the *niger* workers killed them, and this went on till November, when a few were received. From then onwards four, five and six *umbratus* workers were added every day, the *niger* workers no longer attacking them ; neither did they attack the *niger* workers, nor the *fuliginosus* queen. The latter began to swell with eggs again on November 20th. On December 31st, 1917, there were present sixty *niger* workers and a large number of *umbratus* workers ; the latter now surrounding the *fuliginosus* queen. In 1918 the *umbratus* workers started to kill the *niger* workers, all but one having been killed by May 17th, 1918 ; the remaining one being killed by the end of the month. The *fuliginosus* queen gradually got very swollen again, and by May 27th she had laid a bunch of eggs, which was held up by several *umbratus* workers. On June 16th two packets of eggs were present, but they were all eventually devoured by the *umbratus* workers. The virgin *fuliginosus* queen died in May, 1919, having lived in captivity nearly four years. On April 25th, 1919, she was very swollen with eggs, but almost dead, being held up by a number of the *umbratus* workers ; and on May 1st she was quite dead, but still carried about by the workers until May 17th, when her body was cut up. The *umbratus* workers then commenced to die off, so in June they were turned loose in the garden.

On July 17th, 1918, I discovered in the New Forest a very interesting mixed colony of *A.* (*D.*) *fuliginosus* and *A.* (*C.*) *mixtus*, which consisted of about two-thirds of the former workers to one-third of the latter. The two species were walking along together in files on a fence near a railway bridge ; they were quite friendly, tapping

antennae and saluting each other when they met on the tracks, as also when placed together in a small tube. The tracks led right down the brickwork of the bridge to the ground beside the line. It was really a beautiful sight, when the sun was shining, to see the jet-black *fuliginosus* and yellow *mixtus* marching in files up and down the wall of the bridge and saluting each other when they met. *As* mixtus *is very subterranean in its habits, it must have learnt from the* fuliginosus *to march in files in the open.* The tracks also led to and from a thick bramble grove growing by the side of a fence along the buttress of the bridge, and here the nest was evidently situated. Here was a case where a *fuliginosus* female had evidently founded her colony in a nest of *mixtus*[68].

Wasmann records a similar observation to the above—in May, 1923, he found at Valkenburg a mixed colony of *fuliginosus* and *mixtus*, and he pointed out at some length the importance of the fact that both species were seeking food and marching together in files above ground As *A. mixtus* is, when by itself, a very subterranean species, it shows how it had learnt to break away from its instinctive and inherited habits[75].

Lomnicki observed on May 30th, 1918, in "Lemberg (Wulka)" a mixed colony of *fuliginosus* and *umbratus*, walking along the *fuliginosus* tracks ("*fuliginosus-Ameisenstrasse*") on the trunk of an old oak. He also points out that in this case the *umbratus*, which mostly live underground, must have taken on the habits of the *fuliginosus*[71].

On May 29th, 1919, Hallett discovered at Cwrt-yr-ala in Glamorganshire a mixed colony of *fuliginosus* and *mixtus*. The shoots from the stump of a felled oak were covered with Aphides, and all over the stump and shoots numbers of *fuliginosus* and *mixtus* workers occurred together. They were in the proportion of about six to four[74].

Harwood found a mixed *fuliginosus*⊂*umbratus* colony at Studland on May 3rd, 1925, the former being in considerably larger numbers. When the nest was visited again in October it was found to be a pure *fuliginosus* colony, the remaining *umbratus* having evidently died out.

In 1920 Stumper recorded the discovery of three isolated *fuliginosus* females under stones at Neuenstadt in the summer of 1917. He considered that these three instances, in particular two of them, speak against the general validity of the opinion that *fuliginosus* females can found their colonies in nests of *umbratis* and *mixtus*. Two isolated *fuliginosus* queens were found "in their cells" situated under stones; but no brood was present. A third was under a stone which covered a nest of *mixtus* but "her cell" did not communicate with the galleries of the latter[69]. The last mentioned discovery, of course, really confirms the fact that *fuliginosus* females found their colonies in *mixtus* nests. The female

in question was no doubt only waiting for a suitable opportunity to enter the *mixtus* nest. She was probably " in quarantine " for the same reason that beetles of the genus *Atemeles* hang about a nest of *Formica* before they enter it after leaving one of *Myrmica*. It is only in observation-nests that a *fuliginosus* queen has to put up with such a severe test as going straight into a nest of the host-species from her own. After fertilization, should a female not be able to return to the parent colony, or enter a nest of another colony of the same species, she would have to wander about in search of a *mixtus* or *umbratus* nest, and would naturally hang about near by after she had discovered it. She would not only thus lose her own nest " aura," but in part acquire that of the other. As to Stumper's two first instances, it is possible that there may have been colonies of *umbratus* or *mixtus* in the near vicinity. Or, after hunting about in vain for such, these females may have crept under stones for shelter. It is not to be supposed that every female who finds herself stranded is successful in her search for colonies of her hosts.

As the females of *A. fuliginosus* are only slightly larger than the workers, and do not possess large gasters supplied with plenty of fat, and as their fertility is delayed for so long a period, it is clear that they are unable to found colonies unaided ; moreover, it has also been proved by experiment that they are unable to do so !

They are temporary hyper-social parasities, since, as will be seen presently, *A. umbratus* and *A. mixtus* are temporary social parasites of *A. niger* and *A. alienus*.

This may be illustrated as follows (Lomnicki in part) :—

1. Pure *A.* (*D.*) *niger-* (or *alienus-*) colony.
2. *A.* (*D.*) *niger-* (or *alienus-*) colony + *A.* (*C.*) *umbratus* (or *mixtus*) queen.
3. Mixed colony of *A.* (*C.*) *umbratus* (or *mixtus*)* ⌓ *A.* (*D.*) *niger* (or *alienus*).
4. Pure *A.* (*C.*) *umbratus-* (or *mixtus-*) colony.
5. *A.* (*C.*) *umbratus-* (or *mixtus-*) colony + *A.* (*D.*) *fuliginosus* queen.
6. Mixed colony of *A.* (*D.*) *fuliginosus* ⌓ *A.* (*C.*) *umbratus* (or *mixtus*).
7. Pure *A.* (*D.*) *fuliginosus-* colony.

The following species of Myrmecophiles have been taken with this ant in Britain :—

Coleoptera : *Homoeusa acuminata* Märk., *Aleochara ruficornis* Gr., *Microglossa pulla* Gyll., *M. gentilis* Märk., *Oxypoda vittata* Märk., *O. haemorrhoa* Sahlb., *Thiasophila angulata* Er., *T. inquilina* Märk., *Ilyobates glabriventris* Rye, *I. bennetti* Donis., *Myrmedonia haworthi* Steph., *M. limbata* Pk., *M. funesta* Gr., *M. humeralis* Gr.,

* ⌓ This sign was invented by Wasmann in his "Die Zusammengesetzter Nester und gemischten Kolonien der Ameisen," Munster (1891), to express the union of two species to form a single colony. The name of the auxiliary species is always placed after the sign.

M. cognata Märk., *M. lugens* Gr., *M. laticollis* Märk., *Drusilla canaliculata* F., *Notothecta confusa* Märk., *Atheta nitidula* Kr., *A. analis* Gr., *A. exarata* Shp., *A. consanguinea* Epp., *A. brunnea* F., *Quedius brevis* Er., *Heterothops* sp. ? (*nigra* Kr. ?), *Xantholinus atratus* Gr., *Othius myrmecophilus* Kies., *Batrisodes venustus* Reich., *Trichonyx märkeli* Aub., *Ptenidium myrmecophilum* Mots., *P. gressneri* Er., *Dendrophilus punctatus* Hbst., and *Amphotis marginata* F.

Formicidae : *Ponera coarctata* Latr., *Stenamma westwoodi* West., and *Leptothorax nylanderi* Först.

Bracondiae : *Aspilota nervosa* Hal., *Chasmodon apterum* Nees, *Bracon anthracinus* Nees, *Liophron muricatus* Hal., and *Misocrina pugnatrix* Marsh.

Proctotrupidae : *Hoplogryon myrmecobius* K., *Teleas myrmecobius* K., *Tropidopria fuliginosus* Wasm., *Exallonyx wasmanni* K., *E. wasmanni* K. var. *sociabilis* K., *E. myrmecophilus* K., *Lagynodes pallidus* Boh., *L. niger* K. var. *aterior* Box, *Bethylus formicarius* Curt., *Belyta furcata* K. var. *formicaria* K., *Loxotropa formicarum* K., *L. fuliginosi* Box, *L. subregonensis* Box, *Amblyaspis scutellaris* K. var. *hyalinus* K., *A. lasiophilus* K., *A. lasiophilus* K. var. *rufo-petiolatus* K., *Aclista lasiophila* K., *Leptorhaptus myrmecophilus* K., *Proctotrypes fuscipes* Hal., *Ceraphron spinifer* K., *C. fuliginosi* Box, *Conostigmus testaceipes* K., and *Acanthopsilus marshalli* K.

Chalcididae : *Spalangia erythromera* Först., and *Eulophus amempsimus* Wlk.

Cynipidae : *Kleditoma myrmecophila* K., and *K. psiloides* West.

Diptera : *Phyllomyza lasiae* Collin, *Phyllomyza donisthorpei* Smtz., *Pseudacteon* (=*Phora*) *formicarum* Verrall, *Apiochaeta* (=*Phora*) *aequalis* Wood, *A. longicostalis* Wood, *A. ciliata* Zett., *Milichia ludens* Wahl., *Scatopse infumata* Hal., *S. transversalis* L., *Limosina curtiventris* Stnh., *L. fungicola* Hal., *Limosina* sp. ? and *Trineura aterrima* F.

Heteroptera : *Pilophorus perplexus* D. and S., and *Myrmedobia coleoptrata* Fall.

Aphidae : *Schizoneura corni* F., and *Stomaphis quercus* L.

Coccidae : *Newsteadia floccosa* Westw.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic., and *Lepidocyrtus cavernarum* Mon.

Myriapoda : *Julus pulchellus* Leach.

Araneina : *Tetrilus arietinus* Thor., *T. recisus* Camb., *Cryphoeca diversa* Camb., *Cicurina cinerea* Pz., *Drassus troglodytes* C. K., *Hahnia helvola* E. S., *Harpactes hombergi* Scp., *Dysdera cambridgei* Thor., *Microneta innotabilis* Camb., *M. viaria* Bl., and *Micarisoma festiva* C. K.

Acarina : *Urodiscella ricasoliana* Berl., *U. philoctena* Janet,

Uroplitella minutissima Berl., *Trachyuropoda bostocki* Mich., *T. excavata* Wasm., *Antennophorus grandis* Berl., and *Laelaps* (*Cosmolaelaps*) *cuneifer* Mich.

Crustacea : *Platyarthrus hoffmanseggi* Brdt.

Acanthomyops (Donisthorpea) niger L.

[" The Small Black Ant " Gould Account English Ants (1747)[1].] *Formica nigra* Linnaeus Syst. Nat. Ed. 10 1 580 (1758)[2]. *Formica fusca* Christ Naturg. Insekt. 512 (1791)[3]. *Formica nigerrima* Christ Naturg. Insekt. 513 (1791)[4]. *Formica fusca* Latreille Ess. Hist. Fourmis France 43 (1798)[5]. *Formica nigra* Latreille Hist. Nat. Fourmis 156–158 (1802)[6]. *Lasius niger* Fabricius Syst. Piez. 415 (1804)[7]. [" La fourmi brune " Huber Mœurs Fourmis (1810)[8].] *Formica fusca* Förster Hym. Stud. **1** 33 (1850)[9]. *Formica nigra* Schenck Jahrb. Ver. Naturk. Nassau **8** 49–51[10] 144[11] (1852). *Formica pallascens* Schenck Jahrb. Ver. Naturk. Nassau **8** 55 (1852)[12]. *Formica nigra* Daniell Proc. Linn. Soc. Lond. **2** 290–291 (1854)[13]; Wakefield Proc. Linn. Soc. Lond. **2** 293–294 (1854)[14]; Mayr Verh. Zool. Bot. Ver. Wien **5** 284[15] 355[16]. (1855); F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 109–110 (1855)[17]: Cat. Brit. Foss. Hym. 12–13 (1858)[18]. [" Common Garden Ant " Spencer Zool. **17** 6697 (1859)[19].] *Formica nigra* Eaton Ent. Mo. Mag. **5** 298 (1869)[20]. *Lasius niger* H. Müller Berfrucht. Blumen 464 (1873)[21]. *Lasius niger* race *niger* Forel Denkschr. Schweiz. Ges. Naturw. **26** 46[22] 216[23] 257[24] 375[25] 406[26] (1874). *Lasius niger* Lubbock Mo. Mic. Journ. **1877** Pf. 189·1[27]; Saunders Trans. Ent. Soc. Lond. **1880** 208[28]; Er. André Spec. Hym. Europe **2** 192 Pf. 4·1–2 (1881)[29]; Lubbock Ants, Bees, Wasps 37[30] 59[31] (1882); Forel Ann. Soc. Ent. Belg. **30** 206 (1886)[32]; Lubbock Journ. Linn. Soc. Zool. **20** 136 (1888)[33]. [" Small Brown Ant " Thomas Rep. Trans. Cardiff Nat. Soc. **20** 106–109 (1888)[34].] [" Garden Ant " W.E.G. Science Gossip **1889** 214[35].] *Lasius niger* Dalla Torre Cat. Hym. **7** 187 (1893)[36]. *Formica* (*Lasius*) *nigra* Farren-White Ants' Ways 235 (1895)[37]. *Lasius niger* Saunders Hym.-Acul. 25 (1896)[38]; Donisthorpe Ent. Rec. **12** 176 (1900)[39]; Barnes Ent. Mo. Mag. **38** 265 (1902)[40]; Reichenbach Biol. Centralb. **22** 461–463 (1902)[41]; Wheeler Science (n.s.) **18** 830–833 (1903)[42]; Janet Obs. Fourmis 33–34[43] 38[44] 51[45] (1904); von Buttel-Reepen Archiv. Rassen Gesells. Biol. **2** 11 (1905)[46]; Southcombe Proc. Ent. Soc. Lond. **1906** LXXV–LXXVII[47]; Mràzek Zeits. Wiss. Insektenbiol. **2** 109–111 (1906)[48]; Escherich Ameise 88 Tf. A (1906)[49]; Rayward Entom. **39** 219–220 (1906)[50]; Janet Comp. Rend. Acad. Sc. **144** 393–396 (1907)[51]; Donisthorpe Ent. Rec. **20** 281 (1908)[52]: Trans. Leicester Lit.-Phil. Soc. **12** 224 (1908)[53]: Trans. Ent. Soc. Lond. **1909** 415[54]; Stopes and Hewitt Proc. Manchester Lit.-Phil. Soc. **53** 1–6 (1909)[55]; Wheeler Ants 174 (1910)[56]; Donisthorpe Entom. **44** 390 (1911)[57]; Crawley Trans. Ent. Soc. Lond. **1911** 657–663[58]; Donisthorpe Ent. Rec. **24** 6 (1912)[59]: **25** 63 (1913)[60]; Crawley Ent. Rec. **25** 135 (1913)[61]; Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 26–31 (1913)[62]; Donisthorpe Ent. Rec. **26** 39 (1914)[63]. *Donisthorpea nigra* Morice and Durrant Trans. Ent. Soc. Lond. **1914** 423 (1915)[64]. *Lasius niger* Crawley Ent. Rec. **27** 205 (1915)[65]; Schmitz Jaar. Natuur. Genoots. Limburg **1915** 60[66]. *Donisthorpea nigra* Donisthorpe Ent. Rec. **27** 207 (1915)[67]: **28** 3 (1916)[68]. *Formecina* (*Donisthorpea*) *nigra nigra* Emery Bull. Soc. Ent. Italiana **47** 240 (1916)[69]. *Acanthomyops* (*Donisthorpea*) *niger* Donisthorpe Ent. Rec. **30** 21 24 (1918)[70]: **31** 2 21 (1919)[71]: **33** 21 (1921)[72]. *Lasius niger* Wheeler Bull. Mus. Compar. Zool. **64** 543 (1921)[73]. *Acanthomyops* (*Donisthorpea*) *niger* Donisthorpe Ent. Rec. **34** 2[74] 83[75] (1922): **35** 6 (1923)[76]: **36** 51 (1924)[77]: **37** 3 (1925)[78]. *Lasius niger* Lomnicki Bull. Ent. Pologne **4** 2 (1925)[79]. *Lasius* (*Lasius*) *niger* Emery Gen. Ins. 184 229 (1925)[80]. *Acanthomyops* (*Donisthorpea*) *niger* H. Scott Ent. Mo. Mag. **62** 241 (1926)[81].

☿ *Lighter or darker black-brown, the thorax sometimes lighter, mandibles, base of the antennae, articulation of the joints of the legs, and the tarsi yellow. Body pubescent, thickest on gaster.*

Head not emarginate posteriorly; *frontal furrow* indistinct; *eyes* fairly large; *ocelli* very small and indistinct; *scape* and *tibiae* with outstanding hairs. *Long.* 3·4–5 mm.

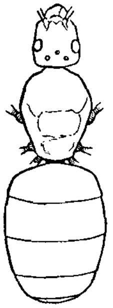


Fig. 84. *Acanthomyops niger* ♀.

♀ *Dark brown, or blackish brown, mandibles, scape, tibiae and tarsi reddish.*

Head small, narrower than thorax, not emarginate posteriorly; *scape* with outstanding hairs. *Thorax* narrower than gaster. *Gaster* large, the same colour beneath as above. *Tibiae* with outstanding hairs. *Wings* large, clear. *Long.* 8–9 mm. (7–10 mm. *teste André.*)

♂ *Blackish brown with apex of the antennae and tarsi, and the articulations of the joints of the legs lighter.*

Head dull; *frontal furrow* distinct; *mandibles* with one tooth, black-brown; *scape* with outstanding hairs. *Thorax* narrowly lighter at the insertion of the wings. *Tibiae* with outstanding hairs. *Wings* clear. *Long.* 3·5–4·7 mm. (3·5–5 mm. *teste André.*)

Original description of *Formica nigra* Linnaeus [Syst. Nat. Ed. 10. **1** 580 (1758)] :—

" F. tota nigra nitida, tibiis cinerascentibus.
Fn. svec. 1022 Formica atra.
Raj. ins. 69. Formica minor e fusco nigricans.
Habitat in Europae *terra.*"

Habitat.

Acanthomyops niger ranges over the whole of Europe, and is also found in Japan, Turkestan, the North of Africa, and Madeira. Ruzsky records it from the Caucasus and Siberia. Lomnicki records it from the Balearic Islands[79] and Wheeler from China[73].

Two varieties occur in the Northern States of America, and a third is found in British America, Alaska, and Colorado.

Forel states that the Japanese examples are absolutely identical with those from Europe, and that it may be admitted to inhabit the whole of the Northern Hemisphere as far south as the 30th

degree of latitude[32]. It probably extends over the whole of the British Isles, but I have no records in England for South Wiltshire, Huntingdonshire, East Gloucestershire, Shropshire, Cheviotland, Westmorland, and in Scotland for Peebles, Selkirk, Roxburgh, Forfar, Kincardine, North Aberdeen, Banff, the South, Mid, and North Ebudes, East Ross, East and West Sutherland, Caithness, the Hebrides, the Orkneys, and the Shetlands.

I have only records for Glamorgan, Brecon, Carmarthen, Pembroke, Merioneth, Carnarvon, and Denbigh in Wales, and Down, Dublin, Wexford, Kilkenny, Queen's Co., Carlow, West Mayo, East and West Galway, Clare, Limerick, North Tipperary, Waterford, Cork, and Kerry in Ireland.

Acanthomyops niger, which according to Wheeler is almost indistinguishable from the *schiefferdeckeri* Mayr of the Baltic amber[56], is one of the commonest ants in Europe.

It has been called the "Garden Ant," but it occurs everywhere, in woods, in clearings, in cultivated and uncultivated places, in shady as well as exposed spots, on the seashore and in towns, but is less abundant, however, in fields and meadows than *A. flavus.*

Forel records it as occurring as high as the region of the fir trees in Switzerland[23], and Hull has sent it to me from West Allendale, situated at the height of 1000 ft.

A. niger nests in the earth, in banks, under stones, in old stumps, etc., and frequently occurs under the pavements, and in masonry in towns, and even in houses. I have seen it running about all over the Caledonian Market, and in many other parts of London. S. O. Taylor sent specimens to me from his house in Leicester, and I observed it swarming in a cellar at Southsea.

This ant constructs—though not to the same extent as *A. flavus*—earthen mound nests which in fields are covered with grass; Daniell records such hillocks in grass in his garden at Chobham[13], Evans found *nigra* mound nests at Longniddry, and I have seen them at Blankenberge in Belgium, at Woking, and at Sandown in the Isle of Wight, etc.

When *niger* nests in tree-trunks and stumps it carves out long galleries in the wood, stretching in all directions; André gives figures of a part of a nest of this species carved in the trunk of a dead tree[29], and I have found it nesting in tree-stumps at Tilgate Forest, Parkhurst Forest, Windsor Forest, etc.

Thomas records finding an interesting nest of "the small brown ant" in a drain-pipe set up as a pedestal for a flower-pot in a garden at Cardiff[34]. The ants had constructed earthen galleries and platforms around the whole of the interior of the pipe, their brood being arranged on these platforms. Daniell mentions that *niger* will nest in flower-pots, at the roots of the plants[13], and I once

found a small colony in the large hollow root of a Yellow-Horned Poppy at Pett near Hastings. On June 10th, 1923, Blair picked up on the downs at Eastbourne a large snail shell occupied by a small colony of this ant[77]. This *Acanthomyops* has the habit of constructing covered ways from its nests to plants on which *Aphidae* occur, and also earthen pavilions to shelter and enclose the latter. These constructions, which are very fragile, being made of earth lightly cemented together, may frequently be seen round the stems of plants and at the foot of trees. Step told me that he had seen one of the covered ways of this ant in a greenhouse, which went right up the wall to the roof, and the ants used this tunnel to enter and leave the greenhouse.

Stopes and Hewitt record earthen tents made by *Acanthomyops niger* in Japan to enclose *Aphidae*—these tents which were sausage-shaped, made of dark sand, mixed with bits of broken shell and very little cement, were constructed on small branches of an Ilex, on the leaves of which *Aphidae* were feeding. Nearly the whole twig and its leaves, except the end, were enclosed in a tent, and covered galleries had been built from these tents to communicate with the subterranean nests of the ants[55].

This species also builds earthen chambers, raised above the ground, round the stems of grass—Escherich gives a good figure of such a structure[49]—which are used as incubators for the ants' brood; they frequently occur at Weybridge, being made of the fine dry sandy soil there, and are very brittle. I observed a small sand crater at Tenby constructed by this ant at the entrance to its nest which was situated on the sand-dunes, the crater probably having been built to prevent the opening into the nest from being blocked up with sand blown by the wind.

This species may often be seen running in and out of holes in hard paths; and tracks, which are very noticeable, occur on the paths, worn bare by the feet of the ants constantly passing to and fro.

When nesting under stones—sometimes under very large ones—*A. niger* constructs most beautiful earthen cells between the ground and the stone, with galleries extending down into the subterranean chambers.

If kept in captivity in "Lubbock" nests these ants generally excavate chambers in a particular manner, with a narrow entrance, and a few pillars of earth as supports. Lord Avebury has figured such a nest, showing the entrance, vestibule, main chamber with some pillars, almost as if to support the roof, and inner room; the queen surrounded by workers, one group of pupae, and several of larvae, sorted according to ages; and the blind wood-lice (*Platyarthrus hoffmanseggi*)[33].

Huber has beautifully described the manner in which the habitations of this species are constructed in nature. He writes:—

"This ant, one of the most industrious of its tribe, forms its nest of stories, four or five lines in height. The partitions are not more than half a line in thickness, and the substance of which they are composed is so finely grained that the inner walls present one smooth, unbroken surface. These stories are not horizontal: they follow the slope of the ant-hill, and lie one upon the other to the ground-floor, which communicates with the subterranean lodges. They are not always, however, arranged with the same regularity, for these ants do not follow an invariable plan; it appears, on the contrary, that nature has allowed them a certain latitude in this respect, and that they can, according to circumstances, modify them to their wish: but, however fantastical their habitations may appear, we always observe they have been formed by concentrical stories. On examining each story separately we observe a number of cavities or halls, lodges of narrower dimensions, and long galleries, which serve for general communication. The arched ceilings covering the most spacious places are supported, either by little columns, slender walls, or by regular buttresses. We also notice chambers that have but one entrance, communicating with the lower story, and large open spaces, serving as a kind of *carrefour*, or cross-road, in which all the streets terminate."[8]

The ants add to the height of their dwelling during and after rain, by bringing up from below small particles of earth and placing them on the top of the nest, and much of their work is done at night. Huber very carefully watched this operation on one of their ant-hills, which had a round form and rose in the grass. He says:—"As soon as the rain commenced, they left, in great numbers, their subterranean residence, re-entered it almost immediately, and then returned, bearing between their teeth pellets of earth, which they deposited on the roof of their nest. I could not, at first, conceive what this was meant for, but at length I saw little walls start up on all sides with spaces left between them. In several places columns, ranged at regular distances, announced halls, lodges, and passages which the ants proposed establishing; in one word, it was the *ébauche* of a new story. . . . Each ant, then, carried between its teeth the pellet of earth it had formed, by scraping with the end of its mandibles the bottom of its abode, which I have often witnessed in open day. This little mass of earth, being composed of particles but just united, could be readily moulded as the ants wished: thus, when they had applied it to the spot where it was to rest, they divided, and pressed against it with their teeth, so as to fill up the little inequalities of their wall. The antennae followed all their movements, passing over each particle of earth as soon as it was placed in its proper position. The whole was then rendered more compact by pressing it lightly with the forefeet. This work went on remarkably quickly. After having traced out the plan of their masonry, in laying here and

there foundations for the pillars and the partitions they were about to erect, they gave them more relief by adding fresh materials. It often happened that two little walls, which were to form a gallery, were raised opposite, and at a slight distance from each other. When they had attained the height of four or five lines, the ants busied themselves in covering in the space left between them by a vaulted ceiling. Quitting, then, their labours in the upper part of the building, as if they judged all their partitions of sufficient elevation, they affixed to the interior and upper part of each wall fragments of moistened earth, in an almost horizontal direction, and in such a way as to form a ledge which, by extension, would be made to join that coming from the opposite wall. These ledges were about half a line in thickness ; and the breadth of the galleries was, for the most part, about a quarter of an inch. Here several vertical partitions were seen to form the scaffolding of a lodge, which communicated with several corridors, by apertures formed in the masonry ; there, a regularly formed hall, the vaulted ceiling of which was sustained by numerous pillars ; further off might be recognized the rudiments of one of those *carrefours* of which we have before spoken, and in which several avenues terminate. These parts of the ant-hill were the most spacious ; the ants, however, did not appear embarrassed in constructing the ceiling to cover them in, although they were often more than two inches in breadth. In the upper part of the angles formed by the different walls they laid the first foundations of this ceiling, and from the top of each pillar, as from so many centres, a layer of earth, horizontal and slightly convex, was carried forward to meet the several portions coming from different points of the large public thoroughfare."[8]

Acanthomyops niger feeds on a variety of substances, it kills and devours flies and other small insects, etc., harbours numerous subterranean *Aphidae* and *Coccidae* in its nests, and also visits other species on plants and shrubs, sucks the nectar of flowers, and collects seeds.

Daniell records seeing *niger* kill and drag off a wounded honey-bee, and he observed thousands of these ants attending the scale *Coccus vitis* L., on vines, and others collecting aphides on Calceolarias[13]. He seemed to think the ants killed these plant-lice, because he saw them tearing off the wings of the latter, but ants are known sometimes to remove the wings of these insects to prevent them from escaping. "W.E.G." recorded the "garden ant" milking some black aphides on broad beans in a garden at Bristol[35], and I have taken many species of *Aphidae* (and also *Coccidae*) in numbers on subterranean roots, and at large, in *niger* nests under stones. Sich sent me specimens of this ant taken in his greenhouse at Chiswick which were attending the scale *Lecanium hesperidum* on ferns, and H. Müller records finding the workers in the flowers of *Chrysoplenium* and *Rosaceae*[21]. Rayward observed *A.*

niger attending the larvae of the Blue Butterfly (*Lycaena bellargus*) at Folkestone on August 11th and 12th, 1906[50].

Wakefield in 1854 saw this ant for days and nights together—he observed them working at midnight—industriously occupied in dragging to its cells the seeds of the common violet (*Viola odorata*)[14]. Spencer noticed the same habit at Blackheath in 1859, and he saw the ants bring out these seeds from their holes on fine days in July[19], and Lord Avebury also records the fact that they collect violet seeds[31]. In 1903 Janet frequently found in nests of *Acanthomyops niger* near Beauvais seeds of *Galium aparine*[45].

H. Scott recorded workers of this ant busily collecting seeds of the common Celandine for some weeks in his garden at Cambridge.[81]

A. niger is a hardy and courageous ant, and it leads an intermediate life between those species which are subterranean in their habits and those which spend most of their time in the open air.

When its nests are disturbed the workers pour out and swarm all over the intruder, and it engages in frequent combats with other ants. It is a deadly enemy to *Acanthomyops flavus*, and remains of the latter are constantly to be found in *niger* nests. Forel mentions a nest of *Formica rufibarbis* which he saw encircled and besieged by thousands of *A. niger* in Switzerland[25].

It is sometimes found in company with other ants, but these cases are probably only accidental, being due to the gradual encroachment by *niger* on the situations occupied by the other species. Schenck states that it lives not seldom with other ants, for example, *flavus* under the same stone, or near each other in the earth, or in the same earth-hill[10], and I found a mixed nest of *flavus* and *niger* under the same stone at Mickleham[39] on May 27th, 1900, and I subsequently pointed out—" As it is unusual for these ants to live together, they were probably encroaching on each other, and eventually the one might exterminate the other."[54]

Barnes records that he dug up two deälated females of *A. niger* in a nest of *Formica sanguinea* at Wellington College on September 6th, 1902[40], but it is probable that these females were only sheltering in the earth after the marriage-flight, and were not really in the *sanguinea* nest. The workers of *niger*, in common with many other species, will lay eggs, more especially in queenless nests, and it was generally supposed that these parthenogetic eggs always produce males, but Reichenbach has shown that these eggs will produce workers[41]—Wheeler very ably commented on this and some other known cases[42]—and recently Crawley has proved the same thing by several experiments with colonies in captivity[58].

The pupae are usually enclosed in cocoons, but Mayr records naked *niger* pupae[15], Janet found naked pupae in a number of nests under large stones at Beauvais[44], and I found them abundant in a mound nest at Sandown, Isle of Wight, on August 7th, 1913[63].

Schenck found the winged sexes as early as June 25th, 1852, at

Nassau[11], and he says the marriage-flight takes place from the beginning of July to the beginning of September[10]. Forel gives the middle of July to the middle of August[26], and Crawley records marriage-flights at Seaton on July 14th and September 15th, 1912[61]. I have found the winged sexes in the nests from July to September, but I once found a male on April 26th, 1913, under a tin on the sand-hills at Tenby[63] and I noticed a marriage-flight at Woking on September 26th, 1912[60]. On August 5th, 1906, Hamm captured a female *niger* with short wings—a mermithogyne—at Bovey Tracey in Devonshire. On July 7th, 1920, I discovered a number of these short-winged females, at Mother Ivy's Bay, N. Cornwall. A fine colony of *niger*, situated under a large flat stone near a stream running from a marsh into the sea, was found to contain very many mermithogynes. These specimens from this nest (which also contained numerous normal winged females and many female and worker cocoons, but no males) are peculiar in themselves, in the fact that nearly every one of them possesses a large oval hole in the mesonotum, about ·7 mm. long and ·25 mm. broad, the object of which I am quite unable to explain. The gasters of such specimens as were dissected were found to contain one or two worms in each[72]. In the collection of the late O. Pickard-Cambridge I found an abnormal specimen of a deälated *niger* female, in that the scale was exceedingly emarginate. Otherwise the insect is quite normal, and this is a simple case of individual variation[75].

The marriage-flight takes place in the afternoon and the following description of one I observed at Folkestone on August 9th, 1911, will serve to illustrate the method adopted by the species of *Acanthomyops* whose males are considerably smaller than the females.

A large colony of *A. niger* occurred in one of the pillars of a gateway to a house in a street in the town, the ants entering the masonry by a hole in the mortar at the base of the pillar. At five o'clock in the afternoon the workers were much excited, running all over the pavement and up and down the pillar, and a few winged ants were out, going in and out of the entrance to the nest. At six o'clock thousands of males and winged females appeared, emerging from the hole, swarming all over the pillar, and climbing to the top, and on the railings and shrubs in the garden. A few couples were observed in copula, and these flew away together, but most of the winged ants flew off separately, rising straight into the air, and going up so high that they were lost to sight. The workers helped some of them to start, tapping them with their antennae, and pushing them to the edge of the top of the pillar. More females than males occurred. By 6.25 p.m. nearly every winged ant had disappeared, and some few females were already on the ground without wings.

A marriage-flight of this species was observed by two of my friends on the same afternoon as the above, at Margate, and Sea-

view in the Isle of Wight. On August 28th I noticed a marriage-flight at Dover, and on my return to Folkestone the same afternoon another was seen there[59]. Marriage-flights of *A. niger* occurred at Weybridge, Putney, Walton, Chobham, and Camberley on August 10th, 1914 (and also of *A. flavus*, *A. umbratus*, and *Myrmica ruginodis* at the first-named locality).

On August 8th, 1915, *A. niger* (and *A. flavus*) was swarming in my garden at Putney from about 4.30 onwards, and they occurred all over Fulham, Putney, and Barnes. In the newspapers of that date vast numbers of winged ants are mentioned as having been observed at Cardiff, and I was informed of flights of *Acanthomyops* species which occurred on that day at Penge, Forest Hill, Streatham, Wallington, Woking, Beckenham, East Farleigh, Brockley, St. Helens, Isle of Wight, Lynton in Devonshire, Bournemouth, Swanage, S. Norwood, Camberley, Otterburn, Northumberland, Crowthorne to Reading, Shaftesbury, Taunton, and Kingston to Kegworth, Leicester.

My son also informed me that he saw numbers of winged ants at Abbeville in France about that date[67]. Crawley also recorded very large marriage-flights of ants of the genus *Acanthomyops* at Weybridge, Walton-on-Thames, and Hersham on August 8th and on the 9th at Westminister Bridge[65].

Huber says it is requisite that the temperature of the air should be at the 15° or 16° Reaumur (67° F.) to allow of our witnessing the departure of the males and females[8].

It is evident that the ants are affected by some atmospheric influence which probably extends at the same time over a large area. Eaton records *A. niger* swarming in the Cactus-house in the Botanical Gardens at Cambridge from April 2nd to 8th, 1869[20], but this may have been due to the fact that the ants' nest was situated near to the hot-water pipes, though the temperature in the house during the day was only 60°–65° Fahrenht., and 55°–60° by night.

On August 28th, 1920, marriage-flights of *A. niger* (and also of *A. flavus* and *Myrmica ruginodis*) took place in the afternoon and evening all over Putney[72]. In 1921 marriage-flights of this ant took place on July 7th and 8th at Putney. On August 20th, another flight occurred in my garden at Putney in the afternoon, and shortly after it had commenced a number of sea-gulls had arrived, and were observed to catch the flying ants high up in the air. Yet another flight was observed (and also of *A. flavus*) on September 5th, when very many swallows collected and levied toll on the ants[74]. On August 20th, 1922, marriage-flights of *niger* took place both at Putney (noted by Miss F. Kirk) and at Horsford in Norfolk, where I was at the time. In the latter locality sexes of *A. flavus*, and species of *Myrmica* were also on the wing. Another flight occurred at Putney on September 21st, all over the district, at

about 5.30 p.m. Sparrows were catching the winged ants both on the ground and in the air, and a large green dragon-fly was " hawking " them, flying up and down the Hazlewell Road[76]. In 1923 marriage-flights occurred from several nests in my garden at Putney on August 4th at 4.30 p.m., summer time. On September 5th, 1924, marriage-flights were observed of *A. niger* (and *A. umbratus*) in Putney at 5 o'clock, summer time, and on October 12th at 3.30 p.m. On the latter occasion sparrows and starlings were " hawking " the winged ants in the air, and some of the former were jumping off the ground and catching the ants as they came out from the brick-work of a wall[78]. Waterston sent me winged females and males (and also workers) found in the stomach of the Lesser Tern, at Blakeney Point, Norfolk, in the summer of 1925 by Collinge.

As an instance of the vast numbers of males and females of *A. niger* which are produced, a record by F. Smith may be mentioned. He writes :—" In the month of September, 1855, I observed at Dover immense clouds of this ant passing over the town towards the sea ; and subsequently, on passing along the beach, I observed a line of their floating bodies extending from the town at least a mile towards St. Margaret's—the line consisted of males and females, and was about a yard broad."[18]

Immediately after the marriage-flight the females get rid of their wings and seek suitable places in which to lay their eggs, as the females of the large-bodied species of *Acanthomyops* (*A. niger, alienus,* and *flavus*) which are considerably larger than their workers, lay eggs only a few days after fecundation, and are very capable of founding their colonies unaided.

They can live for a considerable time without food, partly subsisting on the muscles, which are completely broken down, as Janet has shown, within a few weeks after deälation[51]. The fatty and albuminoid substances derived from the histolysed wing-muscles are carried in the blood to the abdomen, where they are taken up by the ovaries and, no doubt, contribute greatly to the growth of the eggs.

Deälated females, with small egg-packets, may frequently be met with in the autumn, in small cavities under stones, and in holes and crevices in the earth.

Latreille wrote, in 1802, of *A. niger*—one meets often females deprived of the wings, either running on the ground, or hidden, and also alone, under stones[6]. I have frequently met with such females —on August 30th, 1923, two solitary deälated females were found in the empty pupal chambers of *Criocephalus polonicus* under bark in pine stumps, at Padworth. After a marriage-flight they must have selected these situations in which to bring up their broods[77].

On October 28th, 1908, many deälated females of *Acanthomyops niger* and *flavus* were dug up at Luccombe Chine with their eggs in

the little cells they had formed, and in one instance a couple of *niger* females were found together in the same cell with a batch of eggs[52]. Wheeler once found two females of *Acanthomyops brevicornis* together, and he writes—" . . . under very exceptional circumstances, a couple of females from the same maternal nest may meet after their marriage-flight and together start a colony. During August, 1904, I found two deälated females of *Lasius brevicornis* occupying a small cavity under a clump of moss on a large boulder near Colebrook, Connecticut. They had a few larvae and small cocoons, and a couple of tiny callow workers. . . . Without doubt these twin females were sisters that had accidentally met under the same bit of moss and had renewed the friendly relations in which they had lived before taking their nuptial flight. This case is of considerable interest because, as a rule, even sister ants seem averse to such post-nuptial partnerships." [Bull. Amer. Mus. N.H. **22** 41 (1906)].

It is probable, however, that two or more *niger* females may not infrequently combine in starting a colony, though it is a remarkable fact that colonies of this ant are very rarely found with more than one queen. Crawley once found a colony, in August, 1895, which contained two queens[62], but it would seem from the experiments in captivity, shortly to be mentioned, that when two or more females have combined together to found a colony, one of them eventually kills the others, and remains the sole queen in the nest.

This species will not receive strange females of its own species into its nest after the marriage-flight. Southcombe took some newly fertilized females of *A. niger* in July, 1905, and offered some to wild nests, and others to a captive queenless colony. In every case the females were torn to pieces, the queenless nest in particular showing great ferocity towards the strange females[47].

A number of colonies have been brought up in captivity by *niger* females. Janet found an isolated deälated female, with a small packet of eggs in a little cell, on September 7th, which he placed in an observation-nest, the first workers appearing in the following spring ; in other experiments which he had carried out in previous years with females of the same species taken after the marriage-flight during the first days of August, the first workers were reared by the beginning of October[43].

In July, 1914, I brought home a deälated *niger* female, which I had found walking on a bank at Woking, and established her in a small " Crawley-Lubbock " nest. She blocked up the entrance to her cell, and in a day or so laid eggs. No attention was paid to this nest, but by September 1st the female was found to have brought up two small workers.

Von Buttel-Reepen took two deälated females after the marriage-flight on July 22nd, 1903, and placed them in a glass nest with

earth, in which they dug two separate holes and laid eggs by the middle of August. About August 20th one female broke into the cell of the other, brought her eggs, settled with her, and the two females henceforward lived together, heaping their eggs in one bunch. The first larva appeared one month after the eggs were laid, twenty-four in all hatching ; some of these pupated after eight months, and the first worker appeared about a year after the females were fertilized. After five workers had hatched, the females ceased to look after the brood. On August 5th the two females commenced to fight, the workers attacking the female that was getting the worst of the combat. This female died the next day, leaving the colony with a single queen[46].

Mràzek's experiment, though not conclusive, as the females were not actually observed to fight, points to the murder of one female by another. In March, 1904, he found two deälated *niger* females in a closed cell under a stone, and he established them in a small plaster nest with honey, which they drank. On April 11th eggs were laid, and by the beginning of June pupae were present which started to hatch at the end of July, and when there were about thirty workers the females no longer attended to the brood. On returning after an absence from home, he found one female dead and cut in pieces[48].

On July 20th, 1911, Crawley picked up some deälated *niger* females after a marriage-flight at Sea View, and placed three of them in a small box with earth, when they jointly excavated a cell in the earth and built up a roof covering them completely in. Ten days later the cell was opened and found to contain a quantity of eggs. The three females were then introduced into a four-chambered " Janet " nest with a large number of pupae, when one female immediately began to carry the pupae into a dark chamber, and though assisted for a short time by another female, carried over one hundred herself. Next day each female occupied a chamber to herself with pupae, the energetic female having by far the largest number. On August 2nd one of the other two females was found dead in the same chamber with the energetic one—by this date about one hundred and fifty workers were present, and the females had laid eggs and ceased to work. On August 4th some workers attacked and killed the other female, the energetic one being left as the sole queen of the colony[62].

In another experiment carried out by Crawley in the same year with three more *niger* females, similar results were obtained. After workers had been reared, one of the females killed another and was eventually herself killed by the third, which was left in possession of a thriving colony[62].

The gaster of a fertile *niger* female becomes distended with eggs, though not to such an extent as in *fuliginosus* ; the gaster of a female of the former, which I found in a large colony under a

stone at Box Hill on July 30th, 1913[63]—whose total length is eleven mm.—measures seven mm. in length, and four mm. in breadth.

The following species of Myrmecophiles have been taken with *Acanthomyops niger* in Britain :—

Coleoptera : *Homoeusa acuminata* Märk., *Myrmedonia limbata* Pk., *Drusilla canaliculata* F., *Claviger testaceus* Preys., *C. longicornis* Müll., and *Opatrum sabulosum* L.

Formicidae : *Ponera coarctata* Latr., *Myrmecina graminicola* Latr., and *Solenopsis fugax* Latr.

Ichneumonidae : *Pezomachus anthracinus* Först.

Braconidae : *Pachylomma buccata* Nees., and *Blacus mamillans* Ruthe.

Proctotrupidae : *Gonatopus myrmecophilus* K., *G. bicolor* Hal., *G. distinguendus* K., *G. pilosus* Th., *Planopria pedestris* K., and *Loxotropa subterranea* K.

Mymaridae : *Litus cynipseus* Hal.

Diptera : *Pseudacteon* (=*Phora*) *formicarum* Verrall, *Microdon mutabilis* L. (larvae), and *M. eggeri* Mik. (larvae and puparia).

Heteroptera : *Alydus calcaratus* L., *Myrmecoris gracilis* Sahlb., *Nabis lativentris* Boh., *Myrmedobia coleoptrata* Fall., *Pilophorus perplexus* D. and S., and *Systellonotus triguttatus* L.

Aphidae : *Trama troglodytes* Heyd., *T. radicis* Kalt., *Forda formicaria* Heyd., *Pentaphis marginata* Koch, *P. trivialis* Pass., *Geoica carnosa* Buckt., *G. formicina* Buckt., *Schizoneura corni* F., *Aphis plantaginis* Schrank, and *Macrosiphum myrmecophilum* Theob.

Coccidae : *Lecanopsis formicarum* Newst., *Ripersia tomlini* Newst., *R. subterranea* Newst., *R. formicarii* Newst., *R. europaea* Newst., and *Ortheziola vejdovskyi* Sulc.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nicol.

Myriapoda : *Polyxenus lagurus* L.

Araneina : *Tetrilus arietinus* Thor., *Evansia merens* Camb., *Micarisoma festiva* C.K., *Micaria pulicaria* Sund., *Synageles oenator* Lucas, and *Harpactes hombergi* Scp.

Acarina : *Cillibano comata* Leon., *Uroplitella minutissima* Berl., *Trachyuropoda coccinea* Mich. var *sinuata* Berl., *T. laminosa* Berl., *T. excavata* Wasm., *Antennophorus foreli* Wasm., *Laelaps* (*Cosmolaelaps*) *vacuus* Mich., *L.* (*Hypoaspis*) *myrmecophilus* Berl., L. (*Oolaelaps*) *montanus* Berl., and *Uropolyaspis hamuliferus* Mich.

Crustacea : *Platyarthrus hoffmanseggi* Brdt.

Nematodes : *Mermis myrmecophila* Baylis.

Acanthomyops (Donisthorpea) niger L., var. alieno-niger Forel.

Lasius niger alieno-niger Forel Denkschr. Schweiz. Ges. Naturw. **26** 46–47 (1874)[1]. *Lasius alieno-niger* Mayr Tijdschr. Entom. **23** 26 (1880)[2]. *Lasius niger* race *alieno-niger* Er. André Hym. Europe **2** 194 (1881)[3]. *Lasius niger*

var. *alieno-niger* Dalla Torre Cat. Hym. **7** 190 (1893)[4]; Donisthorpe Ent. Rec. **25** 63 (1912)[5]: **26** 39 (1914)[6]; Crawley Ent. Rec. **28** 272 (1916)[7]. *Acanthomyops* (*Donisthorpea*) *niger* var. *alieno-niger* Donisthorpe Ent. Rec. **29** 49 (1917)[8]. *Lasius* (*Lasius*) *niger* subsp. *aliena* var. *alieno-nigra* Emery Gen. Ins. **183** 230 (1925)[9].

Original description of *L. alieno-niger* Forel :—

" La pubescence des tibias, en se redressant, passe insensiblement aux poils. Souvent un, deux ou trois poils seulement aux tibias et aux scapes. Dans une fourmilière les ☿ sont plus claires, plus petites, moins pubescentes ; dans l'autre c'est le contraire. Bref, cet intermédiaire est presque aussi commun que les formes typiques " [1].

This variety is intermediate (in the male, female, and worker) in size, colour, and the pubescence on the tibiae and scape, etc., between *A. niger* and *A. alienus.*

In September, 1912, I discovered several colonies of *alieno-niger* at Weybridge situated in sandy banks which contained males and winged females[5], and in May, 1913, I found a colony under a stone at Bletchington[6].

Hallett has sent workers to me from Treleck in Monmouth and Cwrt-yr-ala in Glamorganshire and Harwood workers from Clacton-on-Sea, as well as males and winged females from a marriage-flight which he observed there on October 12th, 1912. Crawley records it from Porlock[7], and S. O. Taylor from Thurmaston in Leicestershire.

Acanthomyops (Donisthorpea) alienus Först.

Formica aliena Förster Hym. Stud. **1** 36 71 (1850)[1]; Schenck Jahrb. Ver. Naturk. Nassau **8** 51–53 (1852)[2]. *Lasius alienus* Mayr Europ. Formicid. 49 (1861)[3]. *Formica aliena* F. Smith Ent. Mo. Mag. **2** 30 (1865)[4]: Ent. Ann. **1866** 127–128[5]: **1869** 72[6]: Ent. Mo. Mag. **11** 111 (1874)[7]. *Lasius niger* r. *alienus* Forel Denkschr. Schweiz. Ges. Naturw. **26** 46[8] 216[9] 376[10] (1874). *Lasius alienus* Saunders Trans. Ent. Soc. Lond. **1880** 209[11]. *Formica aliena* Parfitt Trans. Devon Assn. Sc.-Art. **12** 514 (1880)[12]. *Lasius alienus* Er. André Spec. Hym. Europe **2** 192 (1891)[13]. *Lasius niger* var. *alienus* Hall Ent. Mo. Mag. **24** 91 (1887)[14]. *Lasius alienus* Perkins Ent. Mo. Mag. **27** 195 (1891)[15]; Wasmann Tijdschr. Entom. **34** 48 (1891)[16]; Dalla Torre Cat. Hym. **7** 181 (1893)[17]; Janet Bull. Soc. Zool. France **18** 169 (1893)[18]. *Formica* (*Lasius*) *aliena* Farren-White Ants' Ways 28[19] 113[20] 122[21] 175[22] 235–236[23] (1895). *Lasius niger* race *alienus* Saunders Hym.-Acul. 25 (1896)[24]; Morley Hym. Suffolk **1** 1 (1899)[25]. *Lasius alienus* D. Sharp Camb. NH. Ins. **2** 140 (1899)[26]; Donisthorpe Ent. Rec. **12** 173 (1900)[27]; Bingham Faun. Brit. India Hym. **2** 342 (1903)[28]; Janet Obs. Fourmis 42–45 (1904)[29]. *Lasius niger* race *alienus* Vic. Hist. Sussex **1** 131 (1905)[30]. *Lasius niger* st. *alienus* Bingham Bull. R. Bot. Gard. Kew (A.S.) **5** 28 (1906)[31]. *Lasius alienus* Escherich Ameise 220 (1906)[32]. *Lasius niger* race *alienus* Frisby Proc. Holmesdale NH. Club **1906** 74[33]; Halbert Irish Nat. **16** 44 (1907)[34]; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 224 (1908)[35]. *Lasius alienus* Mràzek Act. Soc. Ent. Bohem. **4** 139 (1908)[36]. *Lasius niger alienus* Bondroit Ann. Soc. Ent. Belg. **53** 485 (1909)[37]. *Lasius alienus* Donisthorpe Ent. Rec. **23** 15 (1911)[38]. *Lasius niger* var. *alienus* Morley Proc. R. Irish Acad. **31** 24 3 (1911)[39]. *Lasius niger* subsp. *alienus* Donisthorpe Entom. **44** 390 (1911)[40].

Lasius alienus Bondroit Ann. Soc. Ent. Belg. **55** 11 (1911)[41]. *Lasius niger* subsp. *alienus* Donisthorpe Ent. Rec. **24** 7 (1912)[42] : **25** 63 (1913)[43]. *Lasius alienus* Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 27 (1913)[44] ; Donisthorpe Ent. Rec. **26** 39 (1914)[45] ; Pinkney Ent. Rec. **26** 98 (1914)[46]. *Donisthorpea aliena* Hallett Ent. Rec. **28** 221 (1916)[47]. *Formecina* (*Donisthorpea*) *nigra aliena* Emery Bull. Soc. Ent. Italiana **47** 240 (1916)[48]. *Acanthomyops* (*Donisthorpea*) *alienus* Donisthorpe Ent. Rec. **30** 21 (1918)[49] : **31** 2[50] 21[51] (1919) : **36** 51 (1924)[52]. *Lasius alienus* Lomnicki Bull. Ent. Pologne **4** 3 (1925)[53]. *Lasius* (*Lasius*) *niger* subsp. *aliena* Emery Gen. Ins. **183** 230 (1925)[54].

☿ *Lighter or darker brown, mandibles, antennae, and sometimes thorax lighter. Lighter in colour, smaller in size and less pubescent than* niger.

Head not emarginate posteriorly ; *frontal furrow* indistinct ; *ocelli* very small and indistinct ; *antennae* thinner than in *niger ; scape* without outstanding hairs. *Tibiae* without outstanding hairs. *Long.* 2·8–3·8 mm. (2·5–4 mm. *teste André.*)

♀ *Lighter or darker reddish brown, with mandibles, antennae and legs lighter. Lighter in colour than* niger *and less pubescent, the body exhibiting far less "sheen."*

Head small, narrower than thorax, not emarginate posteriorly; *scape* without outstanding hairs. *Thorax* narrower than gaster. *Gaster* large, the same colour beneath as above. *Tibiae* without outstanding hairs. *Wings* large, clear. *Long.* 8–9 mm. (7–9 mm. *teste André.*)

♂ *Lighter or darker brown, mandibles, antennae, and legs lighter. Lighter in colour and smaller in size than* niger.

Head slightly shining ; *frontal* furrow distinct, though not as distinct as in *niger*, with a slight transverse impression before ocelli ; *mandibles* with one tooth, yellowish brown ; *scape* without outstanding hairs. *Thorax* broadly testaceous at the insertion of the wings. *Tibiae* without outstanding hairs. *Wings* clear. *Long.* 3·3–3·5 mm. (3·5–4 mm. *teste André.*)

Original description of *Formica aliena* Förster [Hym. Stud. **1** 36 ☿ ♂ 71 ♀ (1850)] :—

" **Operaria :** Fusca, nitida, cinerascenti-micans, sparse pilosula, antennarum scapo tibiisque nudis ; mandibulis rufis, antennis, tibiis et tarsis pallide testaceis ; ocellis minutissimis et linea frontali impressa vix conspicuis ; metathoracis dorso abbreviato ; squama subrectangulari, parva, supra subrotundata.

Long. 1–1¼ lin.

" **Mas :** Fusco-niger, parum cinereo-micans, antennarum flagellis, thorace circa scutellum tarsisque ferrugineo-pallescentibus ; capite thoraceque pilositate fere obsoleta, scapis pedibusque nudis ; linea frontali impressa, profunda ; alis hyalinis, nervis et stigmate pallide flavescentibus ; subradio basin versus subfusco ; area discoidali parva, subquadrata vel nulla ; squama subrectangulari, apice medio leviter emarginato.

Long. 1½ lin.

" **Femina :** Fusca tota undique cinereo-micans, nitida, corpore toto sparse flavido-pilosulo, antennarum scapis tibiisque praeter pubescentiam adpressam nudis ; antennis, tibiis tarsisque ferrugineo-pallescentibus, coxis et femoribus fuscescentibus ; mandibulis confertim longitudinaliter rugosis, fortiter punctatis ; clypeo subtiliter punctulato, foveolis lateralibus laevibus ; area frontali obsoletissime punctulata, nitida ; scutello in circuitu rufescente ; alis amplis, hyalinis, nervis cum stigmate pallide flavidis, subradio fusco ; squama subcordata, apice subangulatim leviter emarginata.

Long. 3½ lin."

Habitat.

Acanthomyops alienus is widely distributed in Europe, though it does not appear to be as common in the North as *niger*. Ruzsky records it from the Caucasus, Siberia, Turkestan, and Finland, Lomnicki from the Balearic Islands[53], and Bingham from the North-West Himalayas up to 9000 ft.[28].

Dalla Torre sinks *Formica pallitarsis* Provancher [Fauna. Ent. Canada. Hym. 2 598 (1883)] as a synonym of *A. alienus*[17], but Provancher's description does not agree with *alienus*, nor does Wheeler in his list of described North American Ants [Ants 561–572 (1910)] give the latter species for North America, where it is represented by *A. niger* var. *americanus* Emery.

The British distribution is as follows :—

Cornwall, W. : The Lizard (*H. C. Champion*)[43] ; **Cornwall, E.** : Trebetherick (*Hallett*).

Devon, S. : High Peak, Sidmouth (*F. Smith*)[12] ; Stoke Fleming (*Perkins*)[15] ; Seaton (*Crawley*)[43] ; **Devon, N.** : Croyde Bay (*Parfitt*)[12] ; Woolacombe (*Pinkney*)[46] ; Lundy Island (*F. Smith*)[7].

Somerset, S. : Minehead (*Farren-White*)[22] ; Porlock (*Crawley*) ; **Somerset, N.** : Steepholm (*Hudd*).

Wilts, W. : Savernake Forest (*Butler*).

Dorset : The Haven, Poole Harbour (*Hamm*) ; Studland (*Morice*) ; Swanage (*Nevinson*) ; Lulworth (*Farren-White*)[20] ; Winfrith Heath, Godlingstone Heath, and Morden (*Haines*) ; Bloxworth[50] (*O. P.-Cambridge*).

Isle of Wight : Blackgang[27], the Landslip, Shanklin, and Sandown (*Donisthopre*)[43] ; St. Helens (*Hamm*).

Hants, S. : Bournemouth (*Rothney*)[6] ; Hayling Island (*Saunders*)[11] ; New Forest (*J. F. X. King*) ; **Hants, N.** : Fleet (*E. A. Butler*) ; Woolton Hill (*Saunt*).

Sussex, E. : Hastings[30] ; **Sussex, W.** : Littlehampton and Arundel Park (*F. Smith Coll.*) ; Worthing (*Donisthorpe*)[49].

Kent, E. : Deal (*F. Smith*)[4] ; Buckland near Dover (*Hall*)[14] ; St. Margaret's Bay (*Donisthorpe*).

Surrey : Kew (*Bingham*)[31] ; Shirley (*Rothney*) ; Wimbledon Common (*Morice*) ; Chobham (*Saunders*)[11] ; Reigate Heath (*Frisby*)[33] ; Box Hill, Weybridge[42], and Woking (*Donisthorpe*)[43].

Essex, N. : St. Osyth (*Harwood*).

Berks : Wellington College (*Barnes*).

Oxford : Oddington (*Crawley*)[38] ; Bletchington (*Donisthorpe*)[45].

Suffolk, E. : Lowestoft (*Farren-White*)[22] ; Kirkley (*Morice*) ; Blythburgh (*Morley*) ; Thorpe by Aldeburgh (*Tuck*)[25] ; Felixstowe (*Morley*)[25] ; Cove Common (*Rothney*) ; **Suffolk, W.** : Rougham and Mill Heath (*Tuck*)[25] ; Barton Mills (*Donisthorpe*).

Norfolk, W. : Holme-juxta-Mare (*Morley*); Lang Mere (*H. Scott*); Blakeney (*S. O. Taylor*); Hunstanton (*Donisthorpe*)[54].

Cambridgeshire : Cambridge (*D. Sharp*); Grantchester (*H. Scott*); Cherryhinton (*Fryer*).

Gloucester, W. : Stonehouse[19] and Stinchcombe Hill (*Farren-White*)[22]; Durnham Downs (*Smallcombe*); Symonds Yat (*Farren-White*)[22].

Warwick : Napton (*Saunt*).

Glamorgan : Cwrt-yr-ala and Porthcawl (*Hallett*)[49]; Rhosilli and Worm's Head (*T. W. Allen*); Caswell Bay (*Buxton*).

Pembroke : Tenby (*Donisthorpe*)[45]; St. Davids (*T. W. Allen*).

Carnarvon : Conway Castle (*Farren-White*)[21]; Deganwy (*W. Gardner*).

Cheshire : Wallasey (*Hallett*)[51].

Dublin : Lambay (*Halbert*)[34].

Wicklow : Powerscourt (*Dublin Mus. Coll.*).

Mayo, W. : Clare Island (*Johnson*)[39].

Clare : Milltown (*Stellfox*).

Acanthomyops alienus has generally been considered to be a race or subspecies of *A. niger*, but I am inclined to agree with Bondroit that it is quite distinct, and should be regarded as a good species[41].

Although its habits are somewhat similar to those of *A. niger*, still it differs in many ways; it is not nearly so widely distributed nor so common, it lives a more subterranean life, and is of a much more peaceable disposition.

It prefers to dwell in hot exposed places, on shady commons and heaths, and on the cliffs, etc., nesting in the ground under stones and in banks, occurring but rarely in grass, and seldom constructing mound nests. Smith says it has a way of tunnelling under the ground, and of casting up little hillocks after the manner of the mole[6]—I have noticed this habit at Weybridge; Farren-White states it usually makes its burrows in shady places, "with a raised funnel-shaped gate," and he also found it occupying a small mound at Bournemouth[23], and Bingham recorded two colonies in grass in the Herbarium gardens at Kew[31].

Forel says it does not range as high as the sub-alpine regions in Switzerland[9], Wasmann gives its habitat as heaths in Holland[16], and Bondroit states it is only to be found in calcareous regions in Belgium[41]. I found it in abundance all over the sand-hills at Hunstanton, in the flowers of Convolvulus, under refuse, etc.[52], and in rabbits' burrows at Barton Mills[49].

Parfitt records that he captured, in 1867, specimens of the worker and the winged sexes of *alienus* in a nest on the sands in Croyde Bay, North Devon, which he thought were the first taken in this country[12], but F. Smith had found it in July, 1865, on the Deal sand-hills[4], where it is still abundant.

Schenck says he has often met with workers and pupae of *A. alienus* in nests of *F. sanguinea* at Nassau[2].

Nests of *alienus* will receive and hatch both worker and female pupae of *niger* and vice versa, larvae being even accepted in some instances.

As with *niger*, eggs laid by the workers of *alienus* in captivity will produce workers. I have reared such workers in an observation-nest of *A. alienus*—whose queen was a female *A. mixtus*—taken at Weybridge on July 10th, 1912. This nest will be referred to again under the latter species, and also under *A. umbratus* (pp. 262–276). The winged sexes occur from July to November, though Smith stated that they did not appear before the latter part of August[4]. Schenck gives July 13th till late in September[2], Farren-White took males in November[23], and I have found males and winged females in the nests from July 2nd to September 26th.

Mermithogynes occur in this species—D. Sharp mentions that female specimens of *alienus* have been found with short wings, but he incorrectly treats them as intermediate forms between the winged and wingless females[26]. Mràzek has shown that the virgin females of *alienus* may become infested with a worm of the genus *Mermis*, and that when this occurs the insects develop abnormally small wings[36], and Wheeler found on dissecting short-winged females of *A. neoniger*—a species closely related to *A. alienus*—taken in a colony near Manitou, Colorado, that each contained a large coiled Mermis 53–55 mm. long [*Journ. Experim. Zool.* **8** 421 (1910)].

Crawley took several short-winged females of *alienus* in a nest under a stone at Oddington in 1900[38], and he tells me that all the winged females present in this colony were brachypterous. The wing of one of these females, kindly given to me by the captor, measures 4·5 mm. in length as against 10 mm. in a normal female, from which it differs in no other way.

Schenck says *alienus* begins to swarm later than *niger*, and its swarmings continue after those of the latter have ceased[2]; he records a marriage-flight on September 22nd[2]. Hall noticed another on August 7th, 1887, near Dover. He writes :—" Being a still and sultry evening, the air was literally full of males, and the ground and walls covered by myriads of both sexes ; the females had mostly denuded themselves of their wings in order to seek a suitable place for oviposition."[14] The females of *A. alienus* are equally well able to found their colonies unaided as are those of *niger*.

Farren-White discovered in 1881 under a stone at Lulworth a deälated female and three or four very small-sized pupae enclosed in cocoons[20], which were no doubt the female's first brood, this being an incipient colony.

Janet in 1893 isolated an old queen from a nest of *alienus*, which he supplied with food, since she was past the age when a female can subsist on her body-fat and wing-muscles. She laid eggs soon

after her isolation, and reared twelve larvae and a pupa in sixty-one days, and five pupae and one worker in one hundred and two days[18]. This queen lived in his possession for nine years, and during the first year she reared about fourteen workers, during the second, nineteen, the third, twenty-three, the fifth, sixth, and seventh, a hundred, the eighth, forty, and the ninth, fifteen[29].

The under-mentioned myrmecophiles have been taken with *A. alienus* in Britain :—

Coleoptera : *Drusilla canaliculata* F., and *Claviger testaceus* Preys.

Braconidae : *Pachylomma buccata* Nees.

Proctotrupidae : *Gonatopus pilosus* Th.

Diptera : *Pseudacteon* (=*Phora*) *formicarum* Verral, and *Peyerimhoffia brachyptera* K.

Heteroptera : *Nabis lativentris* Boh.

Aphidae : *Trama troglodytes* Heyd., *T. radicis* Kalt., *Forda formicaria* Heyd., *F. viridana* Buckt., *Geoica carnosa* Buckt., *Tetraneura ulmi* Geoff., *Aphis alienus* Theob., and *A. subterranea* Walker.

Coccidae : *Ripersia subterranea* Newst., *R. formicarii* Newst., and *Ortheziola vejdovskyi* Sulc.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic.

Crustacea : *Platyarthrus hoffmanseggi* Brdt.

Nematodes : *Mermis myrmecophila* Baylis.

Acanthomyops (Donisthorpea) brunneus Latr.

Formica brunnea Latreille Ess. Hist. Fourmis France 41 (1798)[1] : Hist. Nat. Fourmis 168 (1802)[2] ; Jurine Nouv. Meth. Class Hymén. 273 (1807)[3]. [" La fourmi brune" Huber Mœurs Fourmis 52 (1810)[4].] *Formica brunnea* Losana Mem. Accad. Sc. Torino 37 319 (1834)[5] ; Schilling Übers. Arbeit. Schles. Ges. varterl. Cultur. 55 (1838, 1839)[6]. *Formica timida* Förster Hym. Stud. **1** 35 (1850)[7] ; Schenck Jahrb. Ver. Naturk. Nassau **8** 53 (1852)[8]. *Formica brunnea* Schenck Jahrb. Ver. Naturk. Nassau **8** 126 (1852)[9]. *Formica timida* Mayr Verh. Zool. Bot. Ver. Wien **5** 361 (1855)[10]. *Formica brunnea* Nylander Ann. Sc. Nat. **5** 68 (1856)[11]. *Lasius brunneus* Mayr Europ. Formicid. 50 (1861)[12]; Taschenburg Hymen. Deutschl. 240 (1866)[13]. *Lasius niger* race *brunneus* Forel Denkschr. Schweiz. Ges. Naturw. **26** 46 49 50 217 (1874)[14]. *Lasius brunneus* Er. André Rev. Mag. Zool. (S. 3) **1** 60 (1881)[16] : Spec. Hym. Europe **2** 193 198 201 (1882)[17] ; Lubbock Ants Bees Wasps 68 (1882)[18]. *Lasius niger st. brunneus* Bryant Fourmis France 56 (1890)[19]. *Lasius brunneus* Wasmann Tijd. Entom. **34** 41 45 48 62 (1891)[20]. *Lasius niger* race *brunneus* Lameere Ann. Soc. Ent. Belg. **36** 64 (1892)[21]. *Lasius brunneus* Dalla Torre Cat. Hym. **7** 182 (1893)[22] ; Wasmann Tijd. Entom. **41** 14 (1898)[23] : **42** 163 (1899)[24] : Arch. Trim. Inst. Grand Ducal Luxemburg **1** 11 12 (1906)[25]; Escherich Ameise 220 221 (1906)[26]. *Lasius niger brunneus* Bondroit Ann. Soc. Ent. Belg. **53** 486 (1909)[27]. *Lasius* (*Lasius*) *brunneus* Ruzsky Hazan Vet. Inst. **29** 620 633 (1912)[28]. *Lasius brunneus* Adam and Förster Mitt. Badisch. Landesver. Naturk. Naturs. **1913** 210[29]. *Lasius* (*Lasius*) *brunneus* Forel Mitt. Schweiz. Ent. Gesell. **12** 52 54 55 (1915)[30]. *Lasius brunneus* Schmitz Natur. Genoots Limburg **1915** 72–75[31]. *Formicina* (*Donisthorpea*) *nigra* subsp. *brunnea* Emery Bull Soc. Ent. Italiana 167 170 174 177 (1916)[32]. *Lasius brunneus* Crawley Ent. Rec. **32** 197 (1920)[33] ; Soudek Zula. Otisk.

Caso Moravsk. Musea Zemsk. **4** 7 (1922)[34]. *Acanthomyops* (*Donisthorpea*) *brunneus* Donisthorpe Ent. Rec. **35** 21–23 (1923)[35]. *Acanthomyops brunneus* Joy Ent. Mo. Mag. **59** 278 (1923)[36]. *Acanthomyops* (*Donisthorpea*) *brunneus* Donisthorpe Ent. Rec. **35** 50 51 117, 121 122 133–139 (1924)[37] : Ent. Mo. Mag. **60** 217–224 (1924)[38] : Ent. Rec. **37** 5 6 (1925)[39]. *Lasius* (*Lasius*) *brunneus* Emery Gen. Ins. **183** 228 (1925)[40]. *Acanthomyops* (*Donisthorpea*) *brunneus* Donisthorpe Ent. Rec. **38** 40–43 52–55 (1926)[41].

☿ *Dirty yellow brown, head above and funiculi of antennae darker; gaster blackish brown; scapes of antennae, mandibles and tarsi brighter yellow.*

Head broader than thorax; *ocelli* small but distinct; *eyes* somewhat smaller than in *niger; frontal furrow* well marked, reaching median ocellus; *scapes* without outstanding hairs. *Thorax* with short silky pubescence more distinct at sides. *Scale* square, slightly emarginate at apex. *Tibiae* without outstanding hairs. *Long.* 3·7–5 mm. (2·5–4 mm. *teste André.*)

Described from a number of workers from Windsor Forest.

♀ *Lighter or darker blackish brown; mandibles, antennae, scale, and legs yellow, femora broadly darker.*

Head almost as broad as thorax (considerably more so than in *niger* or *flavus*), not emarginate posteriorly; *scape* without outstanding hairs. *Thorax* narrower than gaster (but much less so than in *niger*); *scale* slightly emarginate, with three fine bristles at the apical corners. *Gaster* moderate, the same colour beneath as above. *Tibiae* without outstanding hairs. *Wings* smoky. *Long.* 7–8·5 mm. (6–9 mm. *teste André.*)

Described from a number of winged females from Windsor Forest.

♂ *Dark blackish brown; legs and antennae brown, tarsi and apex of antennae lighter.*

Head dull; *frontal furrow* very distinct with a marked impression before ocelli; *mandibles* black-brown armed with two teeth which are very narrowly reddish; *scape* without outstanding hairs; *eyes* without hairs. *Thorax* not lighter at the insertion of the wings. *Scale* with anterior border roundly excised, the angles of the excision pointed and bearing a fine bristle. *Tibiae* without outstanding hairs. *Wings* smoky. *Long.* 4·5–4·7 mm.

Described from a number of specimens from Windsor Forest.

Original description of *Formica brunnea* Latreille [Ess. Hist. Fourmis France 41 (1798)] :—

" 17* F. brune. *brunnea.*

O.p. Ferrugineuse foncée. Yeux, sommet de la tête, et abdomen noirâtres. Ecaille carrée, presque bidentée.

Femelle. Brune noirâtre. Mandibules, antennes, et pattes ferrugineuses. Ecaille bidentée. Abdomen large. Aîles longues : quelques nervures obscures sur la base des antérieures."

The male of *Formica timida* was described by Schenck [Jahrb. Ver. Naturk. Nassau **8** 54 (1852)] as follows :—

" M. 2 L., auch kleiner. Glanzend schwarz. Oberkiefer schwarz mit einem etwas röthlichen zahne, zuweilen zweizähnig. Stirnrinne sehr tief, von den Stirnfeld bis zum mittleren Nabenauge. Augen kahl. Fühler schwarzbraun, die Geissel nach dem Ende etwas heller; Steilchen und Endglied der Geissel weisslich. Beine Schwarzbraun, Gelenke und Tarsen blassräunlich,

oft fast gelblich. Schuppe meist stumpfwinkelig ausgerandet, auf jeder seite der Ausrandung line Spitze mit langen Borsten. Körper sparsam mit Borstenhaaren. Flugel bis zur Mitte schwach bräunlich getrübt, Adern und Randmahl braunlich. Am ähnlichsten der M. der fuliginosa (den Untershied f. bei dieser). Vor dem M. der gelben Arten schon durch die kahlen Augen leicht zu unterscheiden ; characteristisch ist auch die Gestalt der Schuppe."

Habitat.

Acanthomyops brunneus occurs in Europe—France[1], Belgium[21], Holland[22], Switzerland[14], Germany[26], Luxemburg[25], Italy[32], etc. ; Asia—Caucasus[17] ; Asia Minor[17] ; Palestine[17] ; Persia[33] ; Japan[40] ; and Africa—Algeria[17]. I found colonies of a very dark form at Bordighera and Monte Nero in Italy and also in Sicily, which I have called var. *nigro-brunneus.* Emery unfortunately published that this species is not found in the British Isles[40], whereas it had been discovered here two years before the publication of the subfamily *Formicinae* in the Genera Insectorum.

British distribution as at present known :—

Berks : Theale, Wellington College, and near Wokingham (*Joy*) ; Windsor Forest (*Joy* and *Donisthorpe*).

A strong colony of this ant was discovered by Dr. N. H. Joy in the hollow of a large felled poplar, at Theale, in Berkshire, on January 21st, 1923. As he realized that the species was unknown to him, he sent some workers on to me to name, and these I at once recognized as *A.* (*D.*) *brunneus* Latr., an ant new to Britain ; accordingly I introduced it into the British list[35]. On February 6th, 1923, I visited the locality with him, and brought home a number of workers from the poplar tree to form a small colony in an observation-nest.

It is true that *brunneus* was recorded as British by the late F. Smith [Cat. Brit. Fossor. Hym. 11 224 (1858) : Trans. Ent. Soc. Lond. (S. 2) **4** 278 (1858), etc.] ; but in his 1871 Catalogue [Cat. Brit. Hym. Aeul. 2 (1871)] he gives it as a synonym of *umbratus.* It should probably have been referred to *A.* (*C.*) *mixtus* (as neither that species nor *brunneus* possess outstanding hairs on the tibiae), which was not then known as British. Smith's record for Deal consisted of a solitary female, sorted out from a lot of other ants [Ent. Ann. **1858** 39], and was almost certainly *mixtus.* Bingham also recorded this species—on a young dead sparrow near the Herbarium, Kew Gardens [Bull. R. Bot. Gard. Kew (AS) **5** 28 (1906)], but he was probably in error, as he calls it a "common British species," and *brunneus* was not known to occur in Britain then. It was most likely *niger* or *alienus.*

A. (*D.*) *brunneus* is a very timid ant (hence Förster's appropriate name[7]) of retiring habits, and seldom leaves its nest, and as Wasmann pointed out—" . . . as *Lasius brunneus* generally only shows

itself singly, is very fugitive, and possesses nests very hard to find, it can easily be overlooked." When its runs, under the bark of trees, are exposed, the ants seek safety in flight with great rapidity; and sometimes a very little disturbance of the ants will cause them to desert the tree in which they are nesting. It principally nests in trees and old tree-trunks—Schenck[8] says chiefly oak, more seldom in lime; Forel[14] gives walnut, chestnut, and lime; and Mayr[10] records it in *Populus alba* from Vienna—and prefers parks and wooded land to more open country. As a matter of fact *brunneus* is not confined to any particular tree, as I have found it present in oak, elm, ash, beech, poplar, willow, chestnut, hawthorn, and maple. It has also been found under bark, and in rotten wood, and on the Continent under stones, and even in the walls of houses.

On June 20th, 1923, Joy and I visited the Theale locality again and found that the ants had deserted the felled poplar tree in which the colony was originally discovered. Another colony was found in a hawthorn tree near by (from it two young females, one with one wing and the other with a wing stump, some workers, larvae, and worker cocoons were taken); and workers were also found on and under the bark of a large oak tree. The nest, however, of the latter could not be located. Joy subsequently discovered this ant in Windsor Forest, on oak trees, and shortly afterwards I also found such colonies there, which could be detected by the presence of frass outside the bark; but again the actual nests were not traced, and the ants quickly disappeared. On August 30th I went again to look at the hawthorn tree at Theale, but the ants had departed. On breaking into the tree, the wood inside was found to be entirely riddled by the borings of the ants; the colony, therefore, must have been in occupation for a long time.

Although on removing the bark from the trunk, or even the highest branches, of a tree infested by this ant, many workers may be seen in the runs, they quickly scuttle away, and no actual nest can be traced. This is because the nest is situated inside the tree, and unless it be cut down, one would never find the nest itself. I have been fortunate enough to be present when several trees have been cut down, in Windsor Forest, which were inhabited by this ant. The nest may be situated in the roots, in the centre of the tree, or in one of the main branches. In two cases the trees were quite solid up to twelve feet, and thirty feet, from the ground, and thence (in one tree, the trunk, in the other, a main branch) were partly hollow, and filled with frass, teaming with ants—literally thousands in the older tree, which was calculated accurately for me as being 308 years old—and the wood enclosing the frass was all honey-combed and channelled with tunnels and galleries, excavated by the ants. The wood of these galleries was very damp, and harboured the ants' larvae, and cocoons; and also a weevil *Dryophthorus corticalis* Pk., and its larvae and pupae. (This beetle, which

occurred in the greatest profusion, was new to Britain when I discovered it, on July 9th, 1925; and I have only found it in trees inhabited by *brunneus*. Colonel Sainte Claire Deville tells me that *D. corticalis* is also associated with this ant in France—in the Forest of Fontainebleau, etc.)

A False-Scorpion, which proved to be *Chelifer wideri* C. L. K., also occurred in numbers in the frass with the ants. Wallis Kew [Proc. R. Irish Acad. **33** 72 (1916)] writes of this species that it " . . . was established by C. L. Koch on Bavarian specimens, found 'in dem faulen Holzstaube einer Eiche'; Simon found it in the Forest of Fontainebleau, 'sous les écorces de chênes'; while in Britain we know it from Sherwood Forest, in the old forest-land of Richmond Park, and in a small remnant of forest at West Wickham (Kent), always under the bark of old oaks; and, unlike other tree species, it is usually found where the space between the bark and the wood is choked with a characteristic reddish powdery débris." This débris much suggests the work of ants to me!

According to André[17] *brunneus* feeds almost exclusively on the excreta of large aphides which it rears in the galleries of the nest; Lubbock[18] says it devotes itself principally to the aphides which live on the bark of trees; Schenck[8] mentions large grey plant-lice which are found with it, and when disturbed the ants at once take them into the galleries, and Forel [Le Monde Social des Fourmis **3** 47 (1922)] says that plant-lice of the genus *Stomaphis* are those chiefly reared by *Lasius brunneus*. Accordingly I determined to find this Aphid, and on April 24th, 1924, I found under the bark of an oak tree in Windsor Forest, in the runs of *brunneus*, a number of very young green *Stomaphis*. The ants were carrying some of them about, and when disturbed they hurried off with them into safety under the bark. At the same time a cluster of large egg-like cases was found, and these when hatched proved to be the eggs of the plant-louse. On subsequent visits I continually met with this insect under bark of various trees, where the ant occurred. On June 6th I found many very fat large examples, grey in colour, and swollen with young, which proved to be *Stomaphis longirostris* F., an addition to the British list. These plant-lice generally have the end of their very long proboscis buried in the wood of the tree, and it is with considerable difficulty that they can be removed without breaking it. However large they may be, the ants drag and jerk at them unmercifully to make them leave go, so that they can carry them off.

The food of this ant consists chiefly, no doubt, of the excreta of these large aphides, and on one occasion, on October 1st, 1925, I found it attending *Stomaphis quercus* S.; but I have seen the workers carrying *Psocids* and other small insects in their jaws. In captivity they eat flies, etc., and devour honey.

The marriage-flight is said to occur in June and July, and Schenck[8] says it takes place between five o'clock and eight o'clock in the morning. I have found the winged sexes on June 14th and 25th, and July 9th, in cells under the bark ; and in the nest itself when a tree had been cut down. On June 25th, 1924, many males and a number of winged females were running about on the surface of the tree and in the crevices of the bark ; some also being present under the bark. The workers were in a very excited state, running all over the tree, and endeavouring to drag back some of the winged forms beneath the bark. The time was about twelve o'clock noon, " summer time." I should judge that on this occasion the sexes were anxious to leave the tree, but were being restrained by the workers ; the time, or temperature, or some other reason best known to themselves, being unsuitable. One worker remained for a long time standing motionless on the tree, holding in its jaws a dead deälated female, which was hanging down in a vertical position, not touching the tree.

On June 29th, 1925, I found two solitary young deälated females in small holes in trees ; but without any brood. Evidently a marriage-flight had taken place, and the female of this ant starts her colony in such places. I have also found quite young colonies, with very small workers, which have penetrated a short distance into the wood of the tree. On one occasion I discovered a mixed colony of *A.* (*D.*) *brunneus* and *A.* (*C.*) *umbratus* in an ash tree. The *umbratus* workers occurred in the lower part of the tree, but the *brunneus* workers were running all over it, mixing freely with the yellow ants. When examples of both species were placed together in small tubes and boxes, no fighting took place, and the ants were quite friendly together. It would thus appear that an *umbratus* female had founded her colony in a *brunneus* nest at the foot of the tree, in the same way as do *mixtus* and *umbratus* females in nests of *alienus* and *niger* !

In 1925, as this ash tree was in a rotten condition, it became necessary to have it cut down, and this was done on June 25th, when I was able to be present. The *umbratus* workers occurred in large numbers, with their larvae, in cells in soft wood, and frass, in the base of the tree ; but *brunneus* workers were only present in small numbers. Evidently the host-species was gradually dying out[41]. [Crawley—Ent. Record **37** 170 (1925)—has suggested—" that in nature the host-workers (in this genus) desert the nest as soon as the parasitic workers reach sufficient numbers to carry on without them." I cannot agree with this theory at all ; as all the evidence we have from observations made in nature points entirely to the host-workers dying off in the course of time. In the various cases recorded of mixed colonies of *Acanthomyops* species, all proportions in the numbers of the workers of host and parasite species present have been observed.]

It is equally difficult to find a queen in a nest of *brunneus* as it is with *umbratus* and *mixtus*; and although I have taken home large quantities of the wood and frass from nests in trees which have been cut down, I have never found a queen.

I kept for some time in observation-nests some of the ants and larvae from the poplar tree at Theale, and also those mentioned as being taken from the hawthorn tree; but it is a cowardly, stupid, and uninteresting species in captivity. I tried to induce the two colonies to amalgamate without success; nothing would induce the queenless colony to accept one of the young females from the other; she was eventually killed, as were all workers introduced from either colony into the other. The other young female soon died in her own colony, and all the workers gradually died off. These ants frequently " salute " each other; they chewed up wood put into the nest, and would eat a little honey, but not readily. They took a long time to discover the presence of food when introduced into the nest; and when an ant had found it, it did not endeavour to acquaint its fellows with the fact.

My present observation-nest, which I obtained at Windsor Forest on January 16th, 1925, has been more successful, as the ants have not died so fast, and they will eat honey more freely. By May 6th a number of larvae had spun up in cocoons; the ants, however, opened some of these and devoured the pupae. They also ate some of their larvae and some of the larvae devoured their fellows. This colony would never accept young females which I brought back from Windsor; but always killed them. They accepted, however, and piled up in a big heap, large numbers of worker cocoons from other nests; all the ants from which have since emerged, but a few of them are cripples with deformed legs, and twisted antennae. On June 14th, and again on August 16th, September 1st, and December 2nd, etc., very small larvae were present, which must have hatched from parthenogenetic eggs laid by the workers. A number of these larvae eventually pupated in much shorter time than is usual with larvae hatched from parthenogenetic eggs, and from these very tiny workers emerged; smaller than any I have met with in the field. Some six specimens of the little beetle *Batrisodes delaportei* have lived in this nest since January, 1925, and when the nest is uncovered and the ants all rush wildly about, the little *Batrisodes* put in an appearance, and trot about among the ants in a very important and consequential manner.

June 30th, 1926—Very many tiny larvae and numerous small cocoons present.

The following myrmecophiles have been taken by me with *brunneus* in Britain :—

Coleoptera : *Aleochara sanguinea* L., *Microglossa gentilis* Märk., *M. pulla* Gyll., *Oxypoda recondita* Kr., *Ilyobates propinquus* Aub., *Tachyusida gracilis* Er., *Myrmedonia limbata* Pk., *Drusilla canalicu-*

lata F., *Atheta nitidula* Kr., *A. sodalis* Er., *A. analis* Gr., *Euryusa optabilis* Heer., *E. sinuata* Er., *Quedius scitus* Gr., *Xantholinus glaber* Nor., *Leptacinus formicetorum* Märk., *Othius myrmecophilus* Kies., *Stenichnus exilis* Er., *S. godarti* Latr., *Euthia formicetorum* Reitt., *Batrisodes delaportei Aub.*, *B. adnexus* Hampe., *B. venustus* Reich., *Euconnus claviger* Müll., *Trichopteryx montandoni* All., *Ptenidium kraatzi* Mat., *P. turgidum* Pk., *Symbiotes latus* Redt., *Dendrophilus punctatus* Hbst., *Ptinus subpilosus* Müll., and *Dryophthorus corticalis* Pk.

Formicidae : *Leptothorax acervorum* F., and *L. nylanderi* Först.

Proctotrupidae : *Acropiesta striolata* Th., *A. rufiventris* K., *Synacra brachialis* Nees, *Conostigmus innotatus* Kug., *C. alutaceus* Th., *C. lucidus* K., *C. leptothorax* K., *C. dubius* K., *C. new sp. ? C. scoticus* K., *Aclista scotica* K., *Diapria aequata* Th., *Ceraphron scoticus* K , *Belyta nigriceps* Cam., and *Aphanogmus tenuicornis* Th.

Diptera : *Apiochaeta ciliata* Zet., *A. aequalis* Wood, *A. sp.? Limosina crassimana* Hal., and *Atrichopogon lucorum* Mg.

Heteroptera : *Pilophorus perplexus* D. and S.

Aphidae : *Stomaphis longirostris* F., and *S. quercus* L.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic.

Myriapoda : *Proteroiulus fuscus* Am. Stein.

Araneina : *Tetrilus arietinus* Thor. and *Harpactes hombergi* Scp.

Pseudoscorpionina : *Chelifer wideri* C. L. K.

Acarina : *Antennophorus n. sp.? Laelapsis* sps.? and *Oolaelaps* sp.?

Crustacea : *Platyarthrus hoffmanseggi* Brdt.

Acanthomyops (Chthonolasius) flavus F.

[" The Common Yellow Ant " Gould Account English Ants 2[1] 11[2] (1747).] *Formica flava* Fabricius Spec. Insect. 1 491 (1781)[3]. [" La fourmi jaune " Huber Mœurs Fourmis 319 (1810)[4].] *Formica flava* Schenck Jahrb. Ver. Naturk. Nassau **8** 11[5] 56[6] (1852) ; F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 97[7] 108–109[8] (1855) : Cat. Brit. Foss. Hym. 15 (1858)[9]. *Lasius flavus* Mayr Europ. Formicid. 50 (1861)[10]. *Formica flava* Warner Science Gossip **1871** 183[11]. *Lasius flavus* Forel Denkschr. Schweiz. Ges. Naturw. **26** 47[12] 215[13] 257[14] 378[15] 397[16] (1874) ; Lubbock Mo. Mic. Journ. **18** Pf. **189**·2 ; **190**·1–2 ; **191**·1–3 ; **192**·1–2 5 (1877)[17] ; Saunders Trans. Ent. Soc. Lond. **1880** 210[18] ; Er. André Spec. Hym. Europe **2** 195 (1881)[19] ; Lubbock Ants, Bees, Wasps 32[20] 71–72[21] 91–92[22] (1882) ; Wasmann Tijdschr. Entom. **34** 48 (1891)[23] ; D. Sharp Trans. Ent. Soc. Lond. **1893** 202[24] ; Dalla Torre Cat. Hym. **7** 184 (1893)[25] ; Richardson Ent. Mo. Mag. **30** 213 (1894)[26]. *Formica* (*Lasius*) *flava* Farren-White Ants' Ways 164[27] 236[28] (1895). *Lasius flavus* Saunders Hym.-Acul. 24 (1896)[29]. *Lasius niger* Saunders Irish Nat. **12** 68 (1903)[30]. *Lasius flavus* Ernst Biol. Centralb. **25** 47 (1905)[31]. *Formica flava* Rayward Entom. **39** 197 (1906)[32]. *Lasius flavus* Wasmann Naturwiss. Wochenschr. **6** 391–392 (1907[33] ; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 224 (1908)[34] : Ent. Rec. **20** 281 (1908)[35] ; Wheeler Journ. Psychol.-Neurol. **13** 429 (1908)[36] ; Linder Bull. Soc. Vaud. Sc. Nat. **44** 303–310 (1908)[37] ; Forel Bull. Soc. Vaud. Sc. Nat. **45** 341–343 (1909)[38] ; Wasmann Biol. Centralb. **30** 453 (1909)[39] ; Donisthorpe Ent. Rec. **23** 15 (1911)[40] : Entom. **44** 390 (1911)[41] : Ent. Rec. **24** 7 (1912)[42] ; Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 24–26 (1913)[43] ; Donisthorpe Ent. Rec. **25** 268 (1913)[44] :

26 39 (1914)[45]; Stamforth Nat. **1915** 386 390[46]; Schmitz Jaar. Natuur Genoots Limburg **1915** 40[47]. *Formicina* (*Formicina*) *flava* Emery Bull. Soc Ent. Italiana **47** 241 (1916)[48]. *Acanthomyops* (*Chthonolasius*) *flavus* Donisthorpe Ent. Rec. **29** 48 (1917)[49]: **30** 21 (1918)[50]: **31** 2 (1919)[51]: **33** 21 (1921)[52]: **35** 6 (1923)[53]: **36** 51 (1924)[54]: **37** 3 (1925)[55]. *Lasius* (*Lasius*) *flavus* Emery Gen. Ins. **183** 231 (1925)[56].

☿ *Pale yellow, or yellow with the head, and sometimes the gaster, reddish, and in the larger specimens the whole body is more or less yellowish brown. Size very variable.*

Head very slightly emarginate posteriorly; *eyes* smaller than in *niger* and *aliena; ocelli* very small and indistinct; *frontal furrow* indistinct;

Fig. 85. Scales of (1) *Acanthomyops flavus* ☿. (2) *A. umbratus* ☿. (3) *A. mixtus* ☿. (Donisthorpe.)

scape without outstanding hairs. *Thorax* pubescent and hairy above. *Scale* low, broadest at apex, not, or only very slightly, emarginate; *gaster* very pubescent. *Tibiae* without outstanding hairs. *Long.* 2·2–4·8 mm. (2–4 mm. *teste André.*)

♀ *Brown, mandibles brownish red, cheeks, antennae, underside of the gaster and legs yellow.*

Head small, narrower than thorax, very slightly emarginate posteriorly; *scape* without outstanding hairs. *Thorax* narrower than gaster. *Scale* emarginate. *Tibiae* without outstanding hairs. *Wings* infuscate at the base for half their length. *Long.* 7–9·2 mm.

♂ *Blackish brown, shining, antennae and legs brown, with the funiculus tarsi and articulations of the joints of the legs lighter.*

Head shining; *frontal furrow* indistinct, often with a transverse impression before ocelli; *mandibles* with one tooth (very rarely with a few small teeth on the terminal border), black-brown; *scape* without outstanding hairs; *eyes* with a few microscopical hairs. *Thorax* narrowly testaceous at the insertion of the wings. *Tibiae* without outstanding hairs. *Wings* slightly infuscate. *Long.* 3·7–5 mm. (3–4 mm. *teste André.*)

Original description of *Formica flava* Fabricius [Spec. Insect. **1** 491 (1781)]:—

" F. flaua, abdomine ouato pubescente.
Formica flaua squama petiolari. Degeer. Ins. 2.2.326.
5 tab. 42. fig. 24–28.
Habitat in Europae borealis syluis.
Parua, magnitudine tamen differt."

Habitat.

Acanthomyops flavus ranges over the whole of Europe. Ruzsky records it from the Caucasus and Siberia, and it is represented in North America by the subspecies *nearcticus* Wheeler. Dalla Torre[25]

sinks *Formica ruficornis* Fabricius [Syst. Piez. 397 (1804) from India, and *Formica mellea* Provancher (Nat. Canada·12 356 (1881)] from Canada as synonyms of this species, but the descriptions of neither of them agree with *A. flavus*, and the latter is probably synonymous with the *nearcticus* Wheeler. It is widely distributed in the British Isles, but I have no records in England from South Wilts, North-West Yorks, and Westmorland; in Scotland for Dumfries, Kirkcudbrightshire, Selkirk, Roxburgh, Forfar, Kincardine, South and North Aberdeen, Banff, Elgin, the North Ebudes, East Ross, East and West Sutherland, Caithness, the Hebrides, the Orkneys, and the Shetlands; and in Wales for Carmarthen, Cardigan, and Montgomery.

I have only the following records for Ireland :—Donegal, Louth, Dublin, Kildare, Wicklow, Wexford, Carlow, Kilkenny, Queen's Co., King's Co., West Mayo, West and East Galway, Clare, Limerick, North and South Tipperary, Waterford, South Cork and Kerry.

Acanthomyops flavus is a very abundant species, but it is not so common nor so widely distributed as *A. niger*.

It has been called the "turf ant," as it chiefly nests in fields; it is fond of marshy ground, but occurs also in dry situations in the outskirts, rides and clearings (but not in the interior) of woods, rarely occurring in gardens, and never in houses, always nesting in the ground, under stones, etc.

A. flavus raises the well-known earth mounds in meadows which look like mole-hills covered with grass—indeed, Gould mistook them for such, as he writes :—"The yellow Ants most frequently make Choice of those little Eminencies cast up by Moles, from whom they derive the Name of Mole-hills: But from the Habitation they afford these Creatures are more usually called Ant or Emmet Hills. Thus the Inconveniences produced by one Creature tend to the Service of another."[2] Sometimes they occur in hundreds in one field; I have seen such fields near Balmer Lawn in the New Forest, and at Oddington in Oxfordshire, etc. Wasmann has shown that these hillocks do not occur in the sandy regions of Dutch Limburg[23].

Sometimes these hills attain very large proportions; I have seen a large earthen mound raised by this ant in a ride in Parkhurst Forest which was quite three feet in height.

Richardson called attention to the size and number of the ant-hills of *flavus* near Weymouth in 1894, and he suggested that in a wet spring like the last, the earth (Oxford clay) gets rather sodden, and the ants like to raise their dwellings as high as possible so that they may be drier[26]. The chief reason of these hills, however, is to obtain as much benefit as possible from the rays of the sun, and to act as incubators for the ants' brood.

Huber first pointed out that these ant-hills in the Alps have a

peculiar shape, and always face towards the east. He says:—"Those little Yellow Ants, that are in possession of the *pucerons* or *aphides*, serve the purpose of a compass to the Mountaineers, when they are enshrouded in thick fogs, or have lost their way during the night. Their habitations, which are more common, and more elevated in mountains than elsewhere, take an oblong and almost regular shape. They lie in a direction east and west. Their summit, and the greatest slope, always faces the east: but they incline also on the opposite side. I have verified, upon thousands of these ant-hills, this observation of the shepherds. I found a trifling number of exceptions; but only in those instances where these hillocks had been deranged by men, or other animals. They do not preserve this form in the plains, where they are more exposed to such accidents."[4]

These nests have been called ants' nest compasses, and Tissot[33], and more recently Linder[37], have confirmed these observations. The latter has shown that the elongate shape of the mounds is due to the fact that the ants keep extending them in an easterly direction in such a manner that only the extreme easterly and highest portions are inhabited by the insects. Wheeler has observed a similar and equally striking orientation of the mounds of *Formica argentata* in the sub-alpine meadows of Colorado [Journ. Psychol. Neurol. 13 424 (1908)]; and in 1910 I carried a pocket compass with me wherever I was investigating ants' nests, and whenever it was possible to observe their orientation I found they invariably faced the east [Ent. Rec. **23** 11 (1911)].

Sometimes the larger workers of *flavus* are darker in colour, and this is especially the case in old colonies, where many of the ants will be found to be large and dark. In 1902 at Rossbeigh, Co. Kerry, I found several colonies of *flavus*, all the ants of which were more or less brown in colour, but they were unfortunately described by Saunders as a race of *niger* as follows:—"*Lasius niger* Linn. —Pale race with tibiae without exserted hairs, but much larger than ordinary *alienus*."[30] In a colony of *A. flavus* at Bletchington on May 14th, 1913, in which no queen could be found I captured several very large dark workers, many times larger than ordinary workers[45] which measure 4·8 mm. in length and may be called macrergates.

This is a rather weak ant, and is unable to see very well; it uses its antennae to find its way, and its workers hardly ever appear above ground, though a few may sometimes be seen, after rain, adding to the height of their mound. When attacked by other ants they block up the entrances to their nest, retiring to the chambers underground, and are generally defeated.

Landois found a structure in the worker of this species similar to that he observed in *A. fuliginosus* which he considered to be a stridulating organ, and D. Sharp describes it as a very short space

or ring extending all along the base of the dorsum in the third abdominal segment covered with rather coarse irregular lines. The line of demarcation between this and the general surface of the dorsal plate is abrupt, and there is an extreme difference of texture between the space uncovered and that covered by the overlapping part of the preceding segment[24].

Very many root *Aphidae* live in the nests of *A. flavus*, indeed André says this ant lives exclusively on the liquor furnished by these insects[19], and no doubt this is largely the case, but I have found the remains of beetles, etc., in the galleries of *flavus* nests under stones.

If a nest of this ant be dug into in the winter, packets of oblong black eggs will be found in the subterranean chambers, and in the spring these eggs will be seen in the galleries in nests under stones.

Gould (p. 35) thought that these black eggs produced female ants, but young plant-lice hatch from them, which are not, however, the same species which occur in the nests on roots, but belong to a species which lives on plants outside the nests. These eggs are laid in the autumn, and the ants collect them and carry them into their nests, where they remain the whole winter, and when they hatch the ants carry the young aphides out, and place them on their proper food-plants.

Lord Avebury, who witnessed the latter fact himself[21], writes :—
"Such species as *Lasius flavus* represent a distinctly higher type of social life; they show more skill in architecture, may literally be said to have domesticated certain species of aphides, and may be compared to the pastoral stage of human progress—to the races which live on the produce of their flocks and herds"[22]. I have found four species of *Coccidae* in the nests of *A. flavus*, and these ants also attend larvae of blue butterflies, which they milk.

Rayward records that on June 18th, 1906, he found some thirty or more of the larvae of *Lycaena corydon* (the "Chalk Hill Blue") at Reigate, nearly all of which had *Acanthomyops flavus* upon them, and two larvae found resting on the leaves of their food-plant on the crown of an ant-hill were literally covered by these ants, more than twenty being counted on one of them[32].

I have found the winged sexes of *A. flavus* in the nests from June to September, and F. Smith records finding a male on November 5th[8].

The principal time for the marriage-flight of this species is in August; Schenck says it swarms from June to October in Nassau[5], and Forel gives the end of July to the end of August for Switzerland[16]. I have recorded marriage-flights of *flavus* at Putney, August 28th, 1920[52], Horsford in Norfolk, August 20th, 1922[53], Wicken, September 13th, 1923[54], and Box Hill, August 6th, 1924[55]. On

the last occasion mentioned several colonies in Box Hill station were sending forth their males and winged females, the time being 4.45 p.m.

The male settles on the female in the air, and she carries him during the marriage-flight, when two or three males may rest upon her at the same time, and Forel states that a female is often fertilized by a number of males in succession[16].

I have noticed many marriage-flights of *A. flavus* on the same afternoon as those of *A. niger*, and *A. umbratus*, and species of *Myrmica*, and the procedure is much the same as that described for *A. niger.*

Crawley observed at Oddington in 1899 and again in 1900 a number of mermithogynes walking on the road in company with a few normal females[40]—the wings of one of the former which he kindly gave to me measures only 4 mm. in length as against 9 mm. in the normal female—and Evans captured one on the Isle of May on September 24th, 1910.

Bondroit kindly presented me with a pterergate which he took in October, 1910, in a colony of *A. flavus* at Landelies in the province of Hainaut, in Belgium. It is a large dark worker measuring 4·8 mm. in length and has a pair of vestigial wings, one on each side of the mesonotum, measuring about ·4 mm. in length.

The eggs are laid in the autumn—on September 15th, 1911, I found a colony of *A. flavus* under a stone on a small island in Tobermory Bay which contained one queen, a number of workers, many of them large and dark, and many packets of eggs[42]. Eggs are laid again in the spring in April or May. F. Smith states that it is a remarkable circumstance that the larvae of *A. flavus*, which pass the winter in that state are densely covered with pubescence[7], but these would be young larvae hatched from eggs laid in the autumn, and all young ant larvae are much more hairy than full-grown ones. The females of this species, as we have already stated, are capable of founding their colonies unaided, being many times larger than the workers or males, and abundantly endowed with the necessary reserve force for a protracted fast. Isolated females may frequently be found in the autumn in situations suitable for the formation of their colonies. On October 28th, 1908, I dug up many deälated females from little cells with egg-packets in the soft muddy sand of the undercliff at Luccombe Chine[35], and again on August 26th, 1913, a number of isolated deälated females, some with egg-packets, were seen at Blackgang Chine, in small cells under stones and lumps of soft greensand[45].

Ernst proved that this species is self-founding in captivity. In October, 1902, he found at Le Chenois a deälated female under a stone, where she had constructed a small cell. This female he took home, and from eggs laid by her on April 22nd, 1903, larvae appeared in August and pupae in October, the first worker

hatching on November 9th, eleven months after the finding of the queen[31].

Ordinarily the fertilized female brings up her brood alone, but sometimes two or more such females may join together to do so. Forel, about 1873, found under a stone on the Saléve a neat cell occupied by two fertile *flavus* females without brood[14], and Wheeler, on June 15th, 1907, while collecting at Sion in Canton Valais, found two deälated queens of *Acanthomyops flavus* under a stone in a small earthen cavity a few cm. in diameter, in which they were nursing a single packet of eggs and young larvae. Both hastened to remove the brood when the stone was lifted[36].

On April 19th, 1914, Collins and I found a small incipient colony of *A. flavus* under a stone at Bletchington, which consisted of three deälated females, a few very small workers, and a number of little larvae, all three females resting close together on the brood.

On August 6th, 1904, Crawley found four females together under a stone at Oddington, but as there was no brood and no enclosed cell it was probably only a temporary retreat immediately after the marriage-flight and shedding of wings[43].

Hamm dug up an assembly of no less than sixteen queens of *flavus* with about twelve small workers, in the New Forest on April 16th, 1911, which he kept in captivity[43]. No hostility was observed among the females, some of which laid eggs, and larvae were reared, but the whole colony gradually died off, without any workers being brought up.

Wasmann made a discovery in 1909 which seems to indicate that though many females of *flavus* may start a colony together, they eventually split up into groups of not more than two. On September 29th, 1909, he found under a stone in a small cell at Luxemburg, four females with eggs and a dead mutilated body of a fifth, which he thought might have been killed by the others After the first larvae had hatched the females split up into two groups of two each[39]. This species being much less pugnacious than *niger*, fighting among the females is probably of much rarer occurrence.

It is certainly extremely rare to find more than two queens in a well-established *flavus* colony, and usually only one is present. On May 14th, 1913, I observed two deälated females in a colony at Bletchington[45]; on June 9th, 1913, I discovered three deälated females in a very large and populous *flavus* colony under a big stone on Lundy Island[44]; but on June 17th, 1916, at Bewdley, a very populous and prosperous colony was found under a large heavy stone, standing upright against a bank by the side of a road. The nest which was very large contained countless workers, sex and worker pupae, many packets of eggs and no less than nine queens!

A. flavus will not usually receive strange females of its own species into its nest, and, though not so hostile to ants from strange

colonies as *niger*, yet objects to their presence and drives them from its nests.

Lord Avebury made five experiments, in all of which, nests of *flavus*, both with and without a queen of their own, refused to accept a strange fertile *flavus* female, and he concluded that, at any rate in the case of this species, the workers will not adopt an old queen from another nest[20]. On rare occasions, however, workers of *flavus* may accept a strange queen, or one of their own females after fecundation, as Crawley has made several experiments in which such results have been obtained. To mention one of these : In July, 1897, he had a queenless colony of *A. flavus*, containing, however, ten winged virgin females, in a " Lubbock " nest. A strange fertile female was then taken and put in a box with four workers from this nest, and as they seemed friendly the box was turned on its side close to the door of the nest. Presently the workers entered the nest, and the female of her own accord followed them ; ants saluted her, only two attacked her, and finally she was accepted as queen, shortly after which the workers killed all the winged females in the nest[43].

The following species of myrmecophiles have been taken with this ant in Britain :—

Coleoptera : *Homoeusa acuminata* Märk., *Myrmedonia limbata* Pk., *Drusilla canaliculata* F., *Atheta analis* Gr., *Lamprinus saginatus* Gr., *Staphylinus stercorarius* Ol., *Othius myrmecophilus* Kies., *Medon bicolor* Ol., *Claviger testaceus* Preys., *Trichonyx märkeli* Aub., and *Hetaerius ferrugineus* Ol.

Formicidae : *Ponera coarctata* Latr., *Myrmecina graminicola* Latr., and *Solenopsis fugax* Latr.

Braconidae : *Pachylomma buccata* Nees.

Proctotrupidae : *Gonatopus striatus* K., *Paragryon myrmecophilus* K., *Loxotropa subterranea* K., and *L. donisthorpei* K.

Diptera : *Pseudacteon* (=*Phora*) *formicarum* Verrall.

Heteroptera : *Nabis lativentris* Boh., and *Dictyonata tricornis* Sch.

Aphidae : *Paracletus cimiciformis* Heyd., *Trama troglodytes* Heyd., *T. radicis* Kalt., *Forda formicaria* Heyd., *F. viridana* Buckt., *F. hexagona* Theob., *Tycheoides setariae* Pass., *T. setulosa* Pass., *T. hirsutum* Theob., *Pentaphis trivialis* Pass., *Geoica carnosa* Buckt., *G. pellucida* Buckt., *G. setulosa* Pass., *G. albicornis* Koch., *Tetraneura ulmi* De G., *Schizoneura corni* F., *Aphis plantaginis* Schr., *A. ranunculi* Kalt., *A. leontodoniella* Theob., *Macrosiphum formicarium* Theob., *M. phillipsi* Theob., and *M. sonchi* L.

Coccidae : *Ripersia tomlini* Newst., *R. subterranea* Newst., *R. formicarii* Newst., and *Ortheziola vejdovskyi* Sulc.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic.

Pseudoscorpionina : *Ideoroncus cambridgii* L. Koch.

Acarina : *Cilibano comata* Leon., *Uroobovella obovata* C. and B.,

Urodiscella philoctena Trou., *Uroplitella ovatula* Berl., *Trachyuropoda laminosa* C. and B., *T. celtica* Halb., *Urotrachytes formicarius* Lubb., *Antennophorus pubescens* Wasm., and *Laelaps* (*Cosmolaelaps*) *styliferus* Halbert.

Crustacea : *Platyarthrus hoffmanseggi* Brdt.

Mematodes : *Mermis myrmecophila* Baylis.

Acanthomyops (Chthonolasius) umbratus Nyl.

Formica umbrata Nylander Acta. Soc. Sc. Fenn. **2** 1048 (1846)[1]; Förster Hym. Stud. **1** 39 (1850)[2]. *Formica mixta* Förster Hym. Stud. **1** 41 72 (1850)[3]. *Formica umbrata* Schenck. Jahrb. Ver. Naturk. Nassau **8** 59 139 (1852)[4]; F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 106–108 (1855)[5]; Mayr Verh. Zool. Bot. Ver. Wien **5** 365 (1855)[6]; F. Smith Cat. Brit. Foss. Hym. 14 (1858)[7]. *Lasius umbratus* Mayr Europ. Formicid. 50 (1861)[8]. *Formica umbrata* F. Smith Ent. Ann. **1865** 85 88[9]; Hardy Hist. Berwick Nat. Club **6** 394 (1872)[10]. *Lasius umbratus* r. *umbratus* Forel Denkschr. Schweiz. Ges. Naturw. **26** 47[11] 216[12] 379[13] 407[14] (1874) : Bull. Soc. Vaud. Sc. Nat. **14** 60 (1875)[15]. *Formica umbrata* Hardy Hist. Berwick Nat. Club **7** 127 (1876)[16]; B. Cooke Nat. **5** 73 (1879)[17]; Parfitt Trans. Devon Assn. Sc.-Art **12** 514 (1880)[18]. *Lasius. umbratus* Saunders Trans. Ent. Soc. Lond. **1880** 209[19]; Er. André Spec. Hym. Europe **2** 195 (1881)[20]; Fowler Ent. Mo. Mag. **19** 139 (1882)[21]. *Formica umbrata* Hardy Hist. Berwick Nat. Club **12** 446 (1890)[22]. *Lasius umbratus* Dalla Torre Cat. Hym. **7** 191 (1893)[23]. *Lasius flavus* Michael Journ. R. Mic. Soc. **1894** 303[24]. *Formica* (*Lasius*) *umbrata* Farren-White Ants' Ways 208[25] 236[26] 243[27] (1893). *Lasius flavus* Adlerz Entom. Tijdschr. **17** 131 (1896)[28]. *Lasius umbratus* Harrison Entom. **29** 375 (1896)[29]; Saunders Hym.-Acul. **24** (1896)[30]. *Lasius flavus* Donisthorpe Ent. Rec. **9** 246 (1897)[31]. *Lasius umbratus* Morley Hym. Suffolk **1** 1 (1899)[32]; Evans Ent. Mo. Mag. **36** 265 (1900)[33]; Crawley Science Gossip (n.s.) **6** 365 (1900)[34]; Vic. Hist. Worcester **1** 89 (1901)[35]; Barnes Ent. Mo. Mag. **38** 265 (1902)[36]; Jordain Trans. N. Staffs. NF. Club **37** 82 (1903)[37]; Tuck Trans. Norf. Norwich Nat. Soc. **7** 526 (1903)[38]; Vic. Hist. Warwick **1** 73 (1904)[39]; Vic. Hist. Sussex **1** 131 (1905)[40]; Vic. Hist. Cornwall **1** 182 (1906)[41]; Wasmann Archiv. tri. Instit. Grand-Ducal Luxemburg **1906** 12[42]; Vic. Hist. Yorks **1** 216 (1907)[43]; Vic. Hist. Kent **1** 116 (1908)[44]; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 224 (1908)[45]; Morley Guide NH. I. of W. 303 (1909)[46]; Crawley Ent. Mo. Mag. **45** 95 (1909)[47]; Wasmann Zool. Anzeig. **35** 133[48] 137[49] (1909)[50]. *Lasius flavus* (? *L. umbratus*) Crawley Ent. Record **22** 67 (1910)[51]. *Lasius umbratus* Wheeler Psyche **17** 235–243 (1910)[52]; Donisthorpe Ent. Rec. **23** 11[53] 59[54] 237[55] (1911) : Entom. **44** 390 (1911)[56] : Trans. Ent. Soc. Lond. **1911** 180[57]; Evans Scot. Nat. **1912** 106[58]; Hallett Trans. Cardiff Nat. Soc. **44** 2 (1912)[59]; Donisthorpe Ent. Rec. **25** 92 (1913)[60] : Rep. Lancs-Chesh. Ent. Soc. **36** 1912 40 (1913)[61]; Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 47–51 (1913)[62]; Crawley Ent. Rec. **25** 135 (1913)[63]; Brun Biol. Centralb. **33** 27 (1913)[64]; Adlerz Myrornas 63 (1913)[65]; Donisthorpe Ent. Rec. **26** 39–40 (1914)[66]; Pinkney Ent. Rec. **26** 98 (1914)[67]; Crawley Ent. Rec. **26** 142 (1914)[68]; J. B. Elliott Trans. Brit. Mycol. Soc. **1914** 139–142[69]; Crawley Ent. Rec. **27** 205 (1915)[70]; *Donisthorpea umbrata* Donisthorpe Ent. Rec. **27** 207 (1915)[71]; Hallett Ent. Rec. **28** 221 (1916)[72]. *Formicina* (*Formicina*) *umbrata* Emery Acad. Sci. Ist. Bologna **1916** 60–66[73] : Bull. Soc. Ent. Italiana **47** 241 (1916)[74]. *Donisthorpea umbrata* Hallett Trans. Cardiff N.S. **49** 65 (1917)[75]. *Acanthomyops* (*Chthonolasius*) *umbratus* Donisthorpe Ent. Rec. **29** 33 48 49 51 (1917)[76] : **30** 21 23 24 (1918)[77]. *Lasius umbratus* Emery Bull. Soc. Ent. Italiana **54** 9 (1922)[78]. *Acanthomyops* (*Chthonolasius*) *umbratus* Donisthorpe Ent. Rec. **35** 6 (1923)[79] : **37** 3 (1925)[80]. *Lasius* (*Chthonolasius*) *umbratus* Emery Gen. Ins. **183** 233 (1925)[81].

☿ *Usually clear yellow, sometimes reddish, but the whole body of the same colour, size not very variable.*

Head very slightly emarginate posteriorly ; *eyes* small, as in *flavus ; ocelli* very small and indistinct ; *frontal furrow* indistinct ; *funiculus* of antennae with joints longer than broad. *Thorax* hairy, pubescent. *Scale* high, narrowest at apex, slightly emarginate ; *gaster* pubescent and hairy. *Tibiae* with outstanding hairs. *Long.* 3·8–5·5 mm.

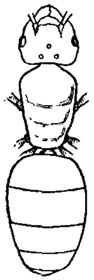


Fig. 86. *Acanthomyops umbratus* ♀.

♀ *Reddish brown, with the mandibles, antennae, and legs lighter.*

Head large, as broad as thorax, emarginate posteriorly ; *funiculus* of antennae with joints longer than broad. *Thorax* pubescent and hairy, only slightly narrower than gaster. *Scale* emarginate at apex ; *gaster* pubescent and hairy. *Tibiae* with outstanding hairs. *Wings* infuscate at the base for half their length, the colour considerably darker than in *flavus. Long.* 7–8 mm.

♂ *Blackish brown, antennae and legs lighter, funiculus and tarsi yellowish. Head* large ; *mandibles* armed with five teeth ; *frontal furrow* distinct ; *eyes* with distinct outstanding hairs. *Wings* as in ♀. *Long.* 4–4·8 mm.

Original description of *Formica umbrata* Nylander [Acta. Soc. Sc. Fenn. 2 1048 (1846)] :—

" *Femina :* nitida cinerascenti sericea pilis brevibus rigidiusculis adspersa, fusca, pallescentia parum interlucente, partibus oris, antennis pedibusque obscure testaceo-pallescentibus ; capite paululum latiori quam thorax, palpis brevibus occipite, concaviusculo, oculis hirtulis ; alis albescenti-hyalinis a basi fere ad medium fusco-umbratis, nervis fusco-brunnescentibus, stigmate obscure fusco ; squama petiolari subrectangulariter-ovali, apice late obtuse-angulatim emarginato."

[†☿] ‡ ♀ " ☿. Long. 7 millimetr.—Fusca, ut in diagnosi dictum, pallescens, dense subtilissime cinerascenti-sericea sparse, breviter cinerascenti-pilosula. Caput dimidio majus quam in *F. flava,* circa os cum partibus ejusdem antennisque testaceo-pallescens, occipite conspicue concaviusculo ; oculi sparse setulosi vel pilis rigidiusculis obsiti (in *F. flava* ♀ pili in oculis sunt obsoletissimi.) Alae anticae a basi fere trans aream discoidalem brunnescentes, stigmate fusco-brunneo, area discoidali solito majori h.e. ejusdem magnitudinis ac in *F. flava,* at dimidio majoris quam in *F. nigra, rufa* &cet. ; posticae versus costam et basin dilutius brunnescentes ; anticae longitudine 8½ millimetrorum (in *F. flava* fere 9¼ millimetr., obsolete versus basin fuscescentia tinctae). Squama proxime sicut in eadem, fusco-pallescens (nec pallida, tantum apice obsolete fuscescente). Abdomen teretiusculum longitudine capitis thoracisque oblongo-ovale, lat. 2½ millimetr., long. 3¼ millimetr., fuscum pallescentia

indistincte (magis tamen apud juniores) interlucente prasertim in ventre et ad insertionem petioli. (In *F. flava* ♀ abdomen est mollius, depressius, corrugaturque saepissime et contrahitur post mortem.) Ceteroquin haec est ut femina *F. flavae*, a qua, ut e jam dictis patet, colore pallido parciori, sordidiori, pilositate corporis uberiori, breviori, capite majori, occipite concaviusculo, oculis hirtulis, alis &cet. satis distincta est.

Mas: subnitidus fusco-niger tenuissime cinerascenti sericeus et pilosulus, palpis, antennarum flagellis, pedum articulationibus tarsisque testaceopallescentibus ; capite sat magno paululum latiori quam thorax, flagellorum articulo primo crassiusculo, oculis hirtulis ; alis albescenti-hyalinis a basi fere ad medium fusco-umbratis nervis brunnescentibus, stigmate fusco ; squama petioli subovali apice subangulatim emarginato ; vaginis genitalium fere aequali longitudine."

"♂. Long. 4½ millimetr. (*F. flava* ♂ 3½ millimetra est longus). Differt a mare *F. flavae* corpore duplo robustiore, multo magis opaco magisque nigro, capite majore, cruce frontis impressiuscula nulla, squama conspicue emarginata, alis distincte versus basin fumatis &cet.—Corpus tenuissime cinerascenti-sericeum, breviter cinerascenti-pilosulum. Caput thorace fere latius occipite subintegro ; mandibulae apice piceo-rufescentes subdenticulatae ; clypeus infra medium linea transversa transeunte impressus ; linea frontis longitudinalis distincta, transversalis, vero nulla (etiam in *F. flava* ♂ saepe deficiens) ; flagellorum articulus primus parum crassior quam sequentes ; oculi setulosi (in *F. flava* ♂ pilis interdum nonnullis parvis indistinctis microscopicis, minus erectis). Alae ut in femina coloratae, et dilutiores, area discoidali trapezoidea saltem dimidio majori quam in *F. nigra* ♂ ; anticae 5½ millimetra longae. (*F. flava* ♂ easdem habet tantum obsoletissime versus basin fuscescentia tinctas vel saepissime totas albescenti-hyalinas, anticas 4½ millimetra longas areaque discoidali trapezoidea parva frequentissime carentes.) Squama ut in diagnosi dictum. Abdomen thorace vix longius ; vaginae externae fimbriatim pilosae."

Habitat.

Acanthomyops umbratus according to Wheeler ranges in the Old World from England to Japan through Northern and Central Eurasia[52], Ruzsky records it from the Caucasus, Siberia, and Finland, and in North America it is represented by four subspecies, not counting *mixtus*, which I regard as a good species.

The distribution in Britain is as follows :—

Cornwall, W. : Land's End (*Bostock*)[24] ; **Cornwall, E. :** Fowey[41] ; Whitsand Bay (*Donisthorpe*)[45] ; Scilly Isles (*Hodson*).

Devon, S. : Exmouth Warren (*Parfitt*)[18] ; Seaton (*Crawley*)[63] ; Bovey Tracey ; **Devon, N. :** Morthoe (*Dixey*) ; Woolacombe (*Pinkney*)[67].

Dorset : Swanage (*Beck*) ; Charmouth (*Donisthorpe*).

Isle of Wight : Landslip (*Fowler*)[21] ; Sandown (*Donisthorpe*)[66] ; Luccombe Chine (*J. Taylor*) ; Blackgang Chine (*Bedwell*) ; Shide (*Morey*)[46] ; Bonchurch (*Morice*).

Hants, S. : Bournemouth (*F. Smith*)[9] ; Hayling Island (*Saunders*)[19] ; Lymington (*Donisthorpe*)[31] ; **Hants, N. :** Fleet (*E. A. Butler*).

Sussex, W. : Bognor (*Guermonprez*)[40] ; **Sussex, E. :** Lewes

(*Dale*)[5]; Brighton (*Unwin*)[40]; St. Leonards (*Piffard*); Guestling[40]; Tilgate Forest (*Donisthorpe*)[45].

Kent, E.: Deal (*Hamm*); Throwley[44], and Huntingfield (*Chitty*); **Kent, W.**: Charlton (*Farren-White*)[27].

Surrey: Shirley and South Norwood (*Rothney*); Richmond Park (*Donisthorpe*); Oxshott (*E. A. Butler*); Chobham (*Saunders*)[19]; Box Hill[52], Mickleham[45], Weybridge[52], and Woking[45] (*Donisthorpe*); Cobham (*Nevinson*); Camberley (*E. E. Green*).

Essex, N.: Colchester (*Harwood*).

Middlesex: Hampstead Heath (*F. Smith*)[5]; Chiswick (*Sich*); Heston and Enfield (*Hodson*).

Berks: Wellington College (*Barnes*)[36].

Oxfordshire: Henley-on-Thames (*H. Scott*); Oxford (*Hamm*); Oddington (*Crawley*); Bletchington (*Donisthorpe*).

Suffolk, E.: Foxhall and Barren Heath, Ipswich (*Morley*)[32]; **Suffolk, W.**: Tostock[32] and Bury St. Edmunds (*Tuck*)[52]; Monk's Soham and Lakenheath (*Morley*)[32]; Brandon district (*Perkins*)[32]; Mildenhall (*Donisthorpe*).

Norfolk, E.: Cromer (*Tuck*)[38].

Gloucester, W.: Stonehouse (*Farren-White*)[26]; Tockington (*Charbonnier*).

Worcester: Bewdley (*Blatch*)[35]; Bank of Severn, Lenchford (*Fletcher*)[35]; Malvern (*Nevinson*).

Warwick: Edgbaston[29] and Harborne (*Harrison*)[39]; Berkswell and Coventry (*Saunt*).

Staffordshire: Colwich (*Martineau*)[37].

Glamorgan: Worm's Head (*T. W. Allen*); Cwrt-yr-ala[59], Porthcawl, Sully, Horton, and Gower (*Hallett*).

Pembroke: Tenby (*Donisthorpe*)[66].

Nottinghamshire: Tollerton (*Crawley*).

Cheshire: Bowdon (*B. Cooke*)[17].

Yorks, Mid. W.: Pannal[43].

Cheviotland: Sneer Hill[10], Langleyford Vale[10], Akeld[16], and Brugh Law (*Hardy*)[22].

Haddington: Luffness Links[58], near Gullane (*Evans*)[33].

Kincardine: Stonehaven (*Rothney*).

Wexford: Rosslare (*Phillips*).

Acanthomyops umbratus is widely distributed in Britain, but it is by no means a common ant; its occurrence is sporadic, and its colonies are generally more or less isolated.

It lives on sandy heaths, in fields, in the clearings of woods, in banks, on cliffs, and on sand-hills, etc., nesting in the earth, often in and at the roots of trees and old stumps, in decayed wood, and under stones. It is sometimes found in walls and houses, and occasionally makes earth mounds.

Forel mentions an immense colony he found in 1875 at Munich

in the foundations of the front of a building, extending for a length of twenty paces[15], and Morley records that Tuck discovered a colony in his house at Tostock in Suffolk[32].

A. umbratus is a phlegmatic ant and is hardly ever to be seen above ground, being even more subterranean in habits than *A. flavus*, and its food chiefly consists of the excreta of *Aphidae* and *Coccidae*, though it also kills and devours small insects, etc.

A. umbratus will receive strange workers of their own species, but will kill workers of *A. mixtus* when introduced into their nest, though I have found they will rear *mixtus* larvae when given to them in captivity. They will also readily rear pupae of *A. fuliginosus*.

On May 1st, 1910, I observed a large number of small, empty land shells (*Caecilioides acicula* Müll.) in the galleries of a nest of *umbratus* situated under a stone at Box Hill; the ants appeared to have collected all the shells together and were resting on them as they do with their own brood[53]. It is, however, exceedingly doubtful that the ants were under the impression that the shells were pupae, or that they would serve as food.

Schenck mentions that *umbratus* possesses a much stronger odour than *flavus*[4]—it is, in fact, similar to, though not so pronounced as, that possessed by *fuliginosus*—and as Brun points out, it is situated in the head[64].

This ant also makes carton, though not to the same extent as *fuliginosus*. In December, 1910, Crawley and I dug up a nest of *umbratus* at Weybridge which I had known for some time, and which was situated in and at the roots of an old stump. As we took two specimens of a beetle (*Myrmedonia humeralis* Gr.) in this nest—the primary host of which is *A. fuliginosus*—and as some of the inner wood of the stump showed traces of the black colour caused by the latter ant in trees infested by it, I suggested that the stump had originally been inhabited by *fuliginosus*[54]. Subsequently when referring to this record I stated—"I now believe that this (the black colour of the wood) was caused by the *umbratus* themselves, as, this year (1912), I have found several nests in the ground under heather at Weybridge, with what were evidently black carton cells for the larvae, deep in the nest at the roots of the heather."[60] In September, 1913, I dug up a nest of *umbratus* at Wellington College, which was situated in the ground at a spot where formerly a tree root or stump had been present, this being nearly entirely decayed. Cells of hard earthy carton were found attached to the roots of plants, which on analysis were found to be composed of :—

1. Numerous hyphae of a fungus, with spores, apparently.
2. A few fine root-fibres (?) of the plant supporting the cells.
3. The bark of the root (*rhizome*) (?) of the plant supporting the cells.

Nest of *Acanthomyops umbratus* in bank at Woking (31.V.15), showing carton nodules and cells on roots. (Morice.)

Nest of *Acanthomyops umbratus* in bank at Woking (31.V.15), showing carton nodules and cells on roots. (Morice.)

Face pa

All these were much more numerous in the **dark-coloured** cells than in the paler ones.

4. Quartzite grains. These predominated.

Some of the root-fibres and bark were, no doubt, taken from the remains of the tree root or stump, and the presence of the fungus would be due to the "cement" used by ants for fastening the quartz grains, etc., together.

Similar cells, of a darker nature, which were again found at Weybridge, in 1913, also contained fungus[66].

On June 12th, 1914, in a bank at Woking I observed some neat carton cells fastened by carton nodules to roots in the centre of an *umbratus* nest,* and on July 16th I found some more dark carton in an *umbratus* nest at Weybridge, its blackish colour contrasting strongly with the light-coloured sandy soil in which it was situated.

Farren-White undoubtedly describes the carton made by *umbratus*, though he evidently did not realize the nature of what he saw. He writes:—"Again, *F. umbrata*, as a rule, is found following the occupation of a miner. Lately, when cutting down what was once a magnificent willow adorning my paddock, but which for the last year or so had been gradually losing its beauty and hastening to decay, I was astonished at discovering in the very heart of the tree a strong colony of *F. umbrata*. It was here occupied as a carpenter as well as a miner. The work of destruction had been commenced, I believe, by a wood-boring beetle, but had been effectually continued and wellnigh completed by the little people, who had shown their wisdom in utilising the decaying wood and fine comminuted particles, which it had doubtless accumulated by its mandibles, which acted as sharp saws, to fashion its many chambers and accommodate the countless numbers of the rapidly increasing family. In fact, the tree measured ten feet ten inches in circumference: its centre, to the height of four feet six inches, was tenanted by a formic population of unnumbered thousands. The rich, brown, honeycombed, finely-wrought woody material occupied a space of about one foot four inches in diameter"[25].

Adlerz writes in his recently published book on ants:—"Besides *L. fuliginosus* only one other ant was known in our part of the world, *Liometopum microcephalum*, which builds carton nests of somewhat more fragile quality in old decaying oaks, poplars, and apricot trees in S.E. Europe. But it is now proved that another of our species of *Lasius*, the yellow *L. umbratus*, has the same habit in Nordland. This species, which resembles our small, usually yellow, mound ant, but is larger and of a clearer yellow, builds in stumps, among roots, under stones, its carton nest of the same black

* Again in 1915 I found at Woking on May 30th a similar nest to that described in the text above. On the following day my friend Mr. Morice accompanied me there and kindly photographed it (see Plate XII).

colour as *L. fuliginosus*, but with stronger walls. This species also cultivates the fungus *Cladotrichum* (possibly a different species from *myrmecophilum*) on the walls of the cells, thus increasing their solidity. The carton which these two species of *Lasius* manufacture is more fragile and brittle than that which is used as building material in the nests of many tropical ants."[65] Wasmann has recently shown that the European *Acanthomyops emarginatus* Ol., also makes carton [Biol. Centralb. 33 264–266 (1913)].

I sent several samples of *A. umbratus* carton from different localities to Dr. Jessie Baylis Elliott, and after obtaining cultures and making a careful study of the fungus this carton contains, she has decided it is a new variety of *Hormiscium pithyophilum* which she has called *H. pithyophilum* var. *myrmecophilum*.[69] Dr. Baylis Elliott tells me *umbratus* carton might almost be considered a pure culture of *Hormiscium*, and *fuliginosus* carton a pure culture of *Cladosporium*.

I have seen the winged sexes in numbers in the nests in July, August, and September, and the winged female in some numbers in a nest at Weybridge in December. Hamm found many winged females in a nest in the Museum grounds at Oxford in April, and Forel records the male in nests in Switzerland in June[14].

When evening sweeping at Mildenhall on September 5th, 1922, numerous males and winged females of *umbratus* were swept up off long grass, and were very active in the net. On September 22nd, of the same year, when evening sweeping at Woking a single winged female was netted. On being placed in a glass-topped box she immediately got rid of her wings[79].

André gives July to September for the marriage-flight[20], and Saunders, August to September[30].

Forel saw may males in the streets of Zurich on August 22nd, 1868[14], and he noticed the same sex leaving the nest, before mentioned, at Munich in immense numbers from five to seven o'clock in the afternoon at the end of July, 1875[15].

Tuck records the winged forms at Cromer in August, 1902[38], Morley observed males and females flying at Foxhall in September, 1892[32], Crawley mentions a marriage-flight at Seaton on September 15th, 1912, at 2 p.m.[63], Charbonnier sent me a winged female to name, which was flying at Tockington on September 27th, 1914, and Beck took a male and female in copula at Swanage on October 6th, 1914. A marriage-flight had evidently taken place at Weybridge on July 29th, 1913, as I saw many deälated females running about on the heath on each side of the railway station ; several had been captured by workers of *Formica rufa* and *F. sanguinea* and were being dragged as prey to the nests of the latter ants, and a dead winged female was found in a nest of the last-named species. A marriage-flight occurred at Sandown, Isle of Wight, on August 27th, 1913, males being observed in the late afternoon in the garden

of my house there, and on the pavements near by, and a female was captured, which had already removed some of her wings[66].

On August 8th, 1915, in the evening after a marriage-flight I captured two deälated *umbratus* females near the entrances to nests of *A. niger* in a road close to my house at Putney. I enclosed them in a box, when the one female killed the other by cutting off its head[71]. The late W. E. Sharp observed a marriage-flight of *umbratus* at Crowthorne on August 4th, 1918—he told me that the winged ants kept pouring out of a number of holes in his lawn.

Crawley records that out of several hundred *umbratus* females observed on August 8th, 1915, during a marriage-flight, at least 50 per cent carried a dead *niger* worker; which it invariably devoured[70].

At Crowthorne on July 30th, 1916, after a marriage-flight I observed a number of deälated females running about in a sand-pit near nests of *A. niger*. One female *umbratus* had a dead *niger* worker in her jaws, and another lay dead near the entrance to a *niger* nest[76]. On August 22nd, 1917, a marriage-flight of this ant took place at Putney, and in my garden. Winged and deälated females were found on the pavements round about, and one deälated female was running on the stonework path near a small *niger* nest, carrying a *niger* worker, which was not quite dead, in her jaws[77]. Again, on September 5th, 1924, marriage-flights occurred in Putney in the afternoon. At five o'clock, summer time, in a road near my house, a deälated female *umbratus* was captured running on the path with a dead *niger* worker in her jaws. She would not let go of her captive, even after she had been placed in a killing-bottle[80]. This curious proceeding is no doubt to enable the *umbratus* female to more easily found her colony in a *niger* nest.

Wasmann has pointed out that—" On account of the concealment of the inner nest one almost never finds the old queens of *L. umbratus, mixtus, brunneus,* and *emarginatus,* whereas they are easily to be found with *L. niger, alienus,* and *flavus* "[42]. This is certainly the case in my experience with *umbratus* and *brunneus,* as however carefully a colony of this ant has been dug up, I have never found the queen.

Barnes found nine deälated *umbratus* females when digging up a nest of *Formica sanguinea* at Wellington College on September 6th, 1902[36], but it is probable they were only sheltering in the earth after the marriage-flight. I have on several occasions found many *A. umbratus* workers when digging up *F. sanguinea* nests at Woking, but the two species were most probably not really living together[53].

It has been demonstrated both by observations in nature and by experiments in captivity that the newly fertilized female of *A. umbratus* founds her colony in nests of *A. niger*. I have also discovered that occasionally she can found her colony in nests of *A. brunneus* (see p. 252).

In the summer of 1895 Adlerz observed a colony of *A. niger* in

Sweden, containing a number of what he took to be *A. flavus* workers, which assisted the *niger* workers to carry off the brood[28], but as suggested by Wasmann the yellow workers were most probably *umbratus* of the first brood[48], which always consists of small ants. Adlerz's explanation of this mixed colony was that the *niger* workers had pillaged some *flavus* pupae and hatched them, but this is very improbable.

On August 1st, 1909, Wasmann discovered near Lippspringe, in Westphalia, a populous colony composed of about one thousand *A. niger* workers, one hundred *A. umbratus* workers, and several males and one winged female of *A. umbratus*[49].

On May 28th, 1914, Crawley found two mound nests near each other (in a field at Woking) belonging to the same colony, which contained workers of *A. umbratus* and *A. niger* in about equal numbers, the former being uniformly small in size[68] ; and on June 12th, 1914, also at Woking, I observed a few large dark *niger* workers among the workers of a large colony of *umbratus* situated in a sandy bank. Several workers of both species were put into a small bottle and taken home ; no fighting took place, and the ants lived together on friendly terms. Again, on August 4th, 1926, I found a large colony of *umbratus* nesting in the roots of an oak tree in Windsor Forest and a few *niger* workers were present among the *umbratus* workers. In these two last cases the *niger* workers were evidently the survivors of the original *niger* colony into which an *umbratus* female had been accepted.

On September 15th, 1912, after a marriage-flight of *A. umbratus* at Seaton, Crawley observed a deälated female *umbratus* enter a hole under a wall which proved to be one of the entrances to a nest of *A. niger*[63].

On August 27th, 1913, after a marriage-flight of *A. umbratus* at Sandown, Isle of Wight, I found a deälated female *umbratus* fighting with some *niger* workers on the pavement near the entrance to a nest of the latter[66] ; on August 10th, 1914, I noticed a deälated female *umbratus*, after a marriage-flight at Weybridge, enter the nest of a large colony of *A. niger*. She forced her way past some *niger* workers standing at the entrance, and though I waited for some time, she did not appear again.

In August, 1896, Crawley proved by experiment that queenless colonies of *A. niger* will accept fertile females of *A. umbratus* and bring up the offspring of the latter until the colony becomes a mixed one of the yellow and black ants. He placed a deälated female *umbratus* picked up near Oxford in a box with two *niger* workers—which she immediately killed—from a colony of the latter which he had in captivity, containing about four hundred workers, worker and female pupae, and a large quantity of eggs. She was then introduced to more of the *niger* workers, and when they were found to be on friendly terms, they were placed near the door of the *niger* nest. The workers immediately entered the nest and were followed

in a few moments by the queen, swarms of ants collected round her and saluted her. A few days later the workers killed the young winged *niger* females that had come to maturity in the nest. The queen began to lay on January 26th, 1897, but for two years only *niger* workers were produced—from parthenogenetic eggs laid by the workers—so that the offspring of the *umbratus* queen must have been devoured in the egg or larval stage. In 1899 the eggs of the queen were at last allowed to reach the pupal stage, but it was not till 1900 that young *umbratus* workers were allowed to live and were unmolested, and by July 18th some twenty were present, and assisted the *niger* workers to tend the brood[34].

In 1908 similar results were obtained[47], and as Lord Avebury found that workers of *A. niger* will live seven years, or more, a colony of *A. umbratus*, therefore, founded by adoption in this manner, must take more than five years to become exclusively *umbratus*[62].

In 1913 Crawley made some nine more experiments, but in all but one the *umbratus* females were killed by the *niger* workers. In the successful experiment, with a small queenless colony of *A. niger*, the *umbratus* female though considerably attacked at first was eventually accepted.

It is conceivable, therefore, that in nature a female might enter an outlying part of a nest and be gradually accepted by most of the workers until she was able to enter the nest proper.

No cases are known of the host-queen and the parasite living together in a nest, so, unless a female can only be adopted by a queenless colony, it must sometimes happen that a female is accepted by a colony already possessing a queen of its own species. In such a case the intruder must either kill the rightful queen herself, as the female of (non-British) *Bothriomyrmex* kills the queen of her host *Tapinoma*, or the workers of the host-species must themselves assassinate their own queen, as do the workers of *Tetramorium caespitum* when they have accepted a female *Anergates atratulus*.

Crawley confined several queens of *umbratus* with queens of *niger*, and the latter were always killed by the former, which, although a little the smaller, is stronger and possesses more powerful mandibles[63].

On July 29th, 1913, I introduced a deälated fertile female *umbratus*, captured after a marriage-flight at Weybridge, into a small queenless colony of *A. alienus* obtained at Weybridge on July 10th, 1912—the queen of which, an *A. mixtus*, had died on November 5th, 1912. The *umbratus* female was promptly attacked and nearly killed, so she was removed and died two days afterwards from the injuries she had received. A second *umbratus* female taken at the same time as the former was introduced into the *alienus* nest and was only slightly attacked ; she killed three of the workers and by the next day she was accepted and lived in the nest as

queen until February, 1917. On May 24th, 1914, she laid her first eggs, and by July 25th she laid a large number and her gaster was considerably swollen. On August 3rd a few workers hatched, which, however, proved to be *alienus* (from parthenogenetic eggs laid by the workers), but on August 27th the first *umbratus* worker appeared. A fair number hatched up to the end of September, all very small; every one, however, was killed after a few days by the *alienus* workers. The *umbratus* female laid many more eggs, and by November a large number of half-grown and small larvae (presumably *umbratus*) were present. In 1915 a large number of small *umbratus* workers were brought up and allowed to live in this nest, and likewise in 1916, when there were more *umbratus* than *alienus* workers. In February, 1917, the nest was allowed to get too dry and the *umbratus* queen and all the workers died.

On September 15th, 1913, Pinkney introduced a deälated *A. umbratus* female taken just after swarming into a colony of *A. alienus* he had obtained at Woolacombe on August 27th, 1913. Only one worker appears to have attacked her, and she was finally accepted the same day, and was alive and well, living as the queen of the colony, on February 15th, 1914[67].

On July 22nd, 1911, I dug up a nest of *A. alienus* at Weybridge which contained plenty of workers and small cocoons, some males, and a number of *umbratus* workers[57], and on July 12th, 1913, I dug up a mixed colony of *umbratus* and *alienus* situated in a sandy bank, also at Weybridge, when both species picked up and carried off the small cocoons exposed by excavating. These two observations and the last two experiments show that *A. alienus* may also act as the host of *A. umbratus* females, and as *alienus* is not nearly so pugnacious an ant as *niger*, the females may more easily accomplish their object.

The following myrmecophiles have been taken with *Acanthomyops umbratus* in Britain :—

Coleoptera : *Myrmedonia humeralis* Gr., *Atheta consanguinea* Epp., *Staphylinus latebricola* Gr., and *Trichopteryx montandoni* All.

Formicidae : *Stenamma westwoodi* West.

Diptera : *Pseudacteon* (=*Phora*) *formicarum* Verrall.

Aphidae : *Forda formicaria* Heyd., *Tycheoides setariae* Pass., and *Geoica formicina* Buckton.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic.

Araneina : *Cryphoeca recisa* Camb.

Acarina : *Cillibano comata* Leon., *Urodiscella philoctena* Trouess., *Uroplitella minutissima* Berl., *Uropolyaspis hamuliferus* Mich., *Trachyuropoda wasmanniana* Berl., *T. bostocki* Mich., *Antennophorus uhlmanni* Hall., *Laelaps* (*Cosmolaelaps*) *cuneifer* Mich., *Sphaerolaelaps holothyroides* Leon, and *Tryoglyphus wasmanni* Mon.

Crustacea : *Platyarthrus hoffmanseggi* Brdt.

Acanthomyops (Chthonolasius) umbratus Nyl., var. **affino-umbratus** var. nov.

Lasius umbratus v. *affino-umbratus ?* Donisthorpe Ent. Rec. **26** 40 (1914)[1]. *Donisthorpea umbrata ?* Donisthorpe Brit. Ants Ed. 1 227 (1915)[2].

☿ *Yellow, whole body almost of the same colour, size not very variable. Head* very slightly emarginate posteriorly; *clypeus* with a fine keel; *eyes* small as in *umbratus,* with distinct hairs; *ocelli* and *frontal furrow* as in *umbratus; funiculus* of antennae with joints distinctly longer than broad. *Thorax* hairy, somewhat more so than in *umbratus; metathorax* with more hairs at sides. *Scale* high, narrowest at apex, considerably emarginate, about as much as in *affinis,* furnished with fine bristles; *gaster* very pubescent, and perhaps slightly more hairy than in *umbratus,* the hairs (bristles) are not as long, however, as in *affinis. Tibiae* with outstanding hairs. *Long.* 4·5–5·8.

Described from a number of workers taken at Tenby on April 24th and 29th, 1913.

I found a number of workers of a large form of *umbratus* (?) walking about on the top of the sand-hills at Tenby in April, 1913, and much digging in the sand only produced more workers. Some of these—which somewhat resemble the continental *A. affinis* Schenck, though more closely related to *umbratus*—were introduced into my *mixto-umbratus* and *umbratus* observation-nest and were all killed by the latter ants, whereas workers of *umbratus* from Wellington College introduced into this nest in 1913, and from Woking and other places in 1912, were all well received[1].

As all these specimens are distinguishable from *umbratus* by their less subterranean habits, their very distinctly emarginate scale, and by the fact that they were always killed when introduced into observation-nests of *umbratus* (contrary to what always occurs when workers of *umbratus* proper are introduced into such nests, no matter whence they come), it seems desirable to give this variety a name. It is also possible that *A.* (*C.*) *affinis* Schenck may be found in Britain some day. André considered *affinis* to be a variety of *bicornis* Förster (in which species the scale is very deeply emarginate), and Emery as a var. of *umbratus* Nyl. The tibiae in both *affinis* and *bicornis* are without outstanding hairs.

Acanthomyops (Chthonolasius) umbratus Nyl., var. **mixto-umbratus** For.

Lasius umbratus mixto-umbratus Forel Denkschr. Schweiz. Ges. Naturw. **26** 48 (1874)[1]. *Lasius mixto-umbratus* André Spec. Hym. Europe **2** 196 (1881)[2]. *Lasius umbratus* var. *mixto-umbratus* Dalla Torre Cat. Hym. **7** 192 (1893)[3]. *Lasius umbratus* Farren-White Ants' Ways 84–85 (1895)[4] (in part). *Lasius umbratus* var. *mixto-umbratus* Donisthorpe Ent. Rec. **25** 64[5] 96[6] (1913). *Donisthorpea umbrata* var. *mixto-umbrata* Hallett Ent. Rec. **28** 221 (1916)[7]. *Lasius mixto-umbratus* Wheeler Psyche **24** 167 (1917)[8]. *Lasius* (*Chthonolasius*) *umbratus* subsp. *mixta* var. *mixto-umbratus* Emery Gen. Ins. **183** 234 (1925)[9].

Original description of *L. mixto-umbratus* Forel :—

" Pilosité intermédiaire entre celle des deux races. Je n'ai pas encore trouvé d'autres fourmilières formant transition entre ces races, vu leur rareté

et leur vie cachée (seulement des ♀ isolées) ; mais leurs caractères distinctifs sont si peu solides, leurs mœurs, leur habitus, leur taille si identiques que je ne doute pas que ces transitions n'existent."[1]

Wheeler records this variety from Northern and Alpine Eurasia from Britain to Japan[8].

Wasmann points out that—" Between *L. umbratus* and *mixtus* intermediate varieties are more common than the pure race forms " [Archiv. Trim. Inst. Grand Ducal Luxemburg **1** 11 (1906)].

This variety embraces forms which are intermediate between *umbratus* and *mixtus* in size, colour, hairiness, and pubescence of the body and legs, etc. ; it may be due in part to hybridism, and is not of a very satisfactory character. The typical forms, however, are very distinct, and it may be as well to tabulate how they may be distinguished here :—

A. umbratus.	**A. mixtus.**
☿ Larger, clear yellow ; hairs (bristles) longer and more abundant ; more pubescent.	☿ Smaller, brownish yellow ; hairs (bristles) shorter and less abundant ; less pubescent.
Eyes a little smaller and flat.	*Eyes* a little larger and less flat.
Funiculus of antennae thin, with joints longer than broad.	*Funiculus* of antennae thicker, with joints broader than long.
Scale higher.	*Scale* lower.
Tibiae with outstanding hairs.	*Tibiae* without outstanding hairs.
♀ Lighter brown ; hairs longer and more abundant ; more pubescent.	♀ Darker brown ; hairs shorter and less abundant ; less pubescent.
Head larger, more emarginate posteriorly.	*Head* smaller, less emarginate posteriorly.
Funiculus thin, with joints longer than broad.	*Funiculus* thicker, with joints not longer than broad.
Scale emarginate at apex.	*Scale* not emarginate at apex.
Tibiae with outstanding hairs.	*Tibiae* without outstanding hairs.
Wings with dark colour not reaching so far across ; *discoidal cell* larger.	*Wings* with dark colour reaching further across ; *discoidal cell* smaller.
♂ More robust, less shining and more pubescent.	♂ Less robust, more shining and less pubescent.
Mandibles with more distinct teeth.	*Mandibles* with less distinct teeth.
Eyes with outstanding hairs.	*Eyes* without outstanding hairs.
Wings with dark colour not reaching so far across ; *discoidal cell* a little larger.	*Wings* with dark colour reaching further across ; *discoidal cell* a little smaller.

I found several colonies of *mixto-umbratus* at Weybridge in 1912, males and winged females occurring with them in numbers in September[5] ; Hallett has sent it to me from Porthcawl, and Phillips from Rathdown, Queen's Co. Specimens I took at Bletchington in May, 1913, might be called this var., as the workers are somewhat intermediate in colour, etc., and the partly winged female has a few outstanding hairs on the tibiae. The two females which

were taken in nests of *A. alienus* at Weybridge, and which will be mentioned under *mixtus*, also have a few hairs on the tibiae. It appears probable that the colony recorded by Farren-White in his garden at Stonehouse would also come under *mixto-umbratus* ; he writes, when speaking of specimens of *A. mixtus* given to him by Bignell :—" He kindly furnished me with specimens—they are marvellously like *Lasius umbratus* or *Formica umbrata* ; the workers and males especially so. The pubescence, however, is not so conspicuous upon the tibiae in the workers and females as in *umbratus*, and the colour of the females is of a dark sepia brown rather than of a reddish brown or mahogany tint, as in the typical specimens of *umbratus*. However, I have specimens of *L. umbratus* intermediate in its degree of pubescence and in its colouring between the two extremes. One with a reddish tinge, another of the pale yellowish

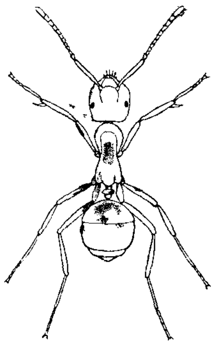


Fig. 87. *A. mixto-umbratus* ☿ with patches of algae on body and legs.

brown kind, and a third of the dark sepia brown, precisely similar in its colouring to Mr. Bignold's [*sic*] specimens, from a very strong and long-established colony of *umbratus* in my garden. This colony for very many years has produced no females, males having been developed in their thousands, nay, tens of thousands, but not a single female having come within view. In 1882, however, the species swarmed in the Vicarage, and must have come up through the foundations in some mysterious way. The males and females were accompanied by the workers, who seem to exercise over them a singular and controlling power. All the females were of the dark brown type with a fine silky sheen, and the pubescence I find more marked and clearly defined in some specimens than in others "[4].

By " pubescence " on the tibiae, etc., Farren-White means the outstanding hairs. It is evident that though the typical forms are

quite distinct, these intermediate varieties are more confusing and difficult to deal with.

On August 11th, 1912, when at Weybridge in company with Professor Wheeler, we found two colonies of this variety, very many of the ants of both being infested with a curious dark brown warty growth in patches on parts of the body and legs—this Wheeler thought might be a fungus which was unknown to him.

I kept a number of these ants in captivity, and added uninfested workers of *umbratus* from other localities ; the growth, however, did not increase nor spread to the new ants, but rather seemed to decrease. I sent some of the infested ants alive, and others in spirit, to Dr. Baylis Elliott, and she considered the patches were colonies of unicellular organisms growing on the outside of the ants[6] ; eventually she came to the conclusion that they were not fungoid growths, but probably colonies of an alga.

I have taken the Acari, *Cillibano comata* Leon., *Antennophorus uhlmanni* Hall., and *Sphaerolaelaps holothyroides* Leon., in nests of *A. mixto-umbratus.*

Acanthomyops (Chthonolasius) mixtus Nyl.

Formica mixta Nylander Acta. Soc. Sc. Fenn. 2 1050 (1846)[1] ; Schenck Jahrb. Ver. Naturk. Nassau **8** 64–66[2] 139[3] (1852) ; Mayr Verh. Zool. Bot. Wien **5** 367 (1855)[4]. *Formica brunnea* F. Smith Trans. Ent. Soc. Lond. (n.s.) **4** 1857 278 (1858)[5] : Proc. 88 (1858)[6] : Cat. Brit. Foss. Hym. 11[7] 224[8] (1858) : Ent. Ann. **1858** 39[9]. *Lasius mixtus* Mayr Europ. Formicid. 50 (1861)[10]. *Lasius umbratus* r. *mixtus* Forel Denkschr. Schweiz. Ges. Naturw. **26** 47[11] 216[12] 407[13] (1874). *Lasius mixtus* Er. André Spec. Hym. Europe **2** 196 (1881)[14] ; Bignell Entom. **14** 262 (1881)[15] ; Young Nat. **3** 191 (1882)[16] ; Dalla Torre Cat. Hym. **7** 187 (1893)[17] ; Janet Etudes. Fourmis **13** 1–58 (1897)[18]. *Lasius umbratus* race *mixtus* Grimshaw Ann. Scot. Nat. Hist. **1908** 89[19]. *Lasius mixtus* Donisthorpe Ent. Rec. **23** 236–238 (1911)[20]. *Lasius umbratus* subsp. *mixtus* Donisthorpe Entom. **44** 390 (1911)[21]. *Lasius umbratus* race *mixtus* Evans Scot. Nat. **1912** 106[22]. *Lasius mixtus* Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 51 (1913)[23] ; Donisthorpe Rep. Lancs-Chesh. Ent. Soc. **36** 1912 40 (1913)[24] : Ent. Rec. **25** 64[25] 268[26] 291[27] (1913). *Lasius umbratus* subsp. *mixtus* Hallett Trans. Cardiff Nat. Soc. **45** 3 (1913)[28]. *Donisthorpea mixta* Hallett Ent. Rec. **28** 221 (1916)[29]. *Formicina (Formicina) mixta* (Emery Acad. Sci. Ist. Bologna **1916** 60–66[30] ; Bull. Soc. Ent. Italiana **47** 242 (1916)[31]. *Acanthomyops (Chthonolasius) mixtus* (Donisthorpe) Ent. Rec. **31** 4–5 (1919)[32] : **33** 21 (1921)[33] : **36** 52 (1924)[34]. *Lasius (Chthonolasius) umbratus* subsp. *mixta* Emery Gen. Ins. **183** 234 (1925)[35].

☿ *Dirty yellow in colour, being darker, more brownish than* umbratus, *mandibles and funiculus of the antennae reddish. The whole body less hairy and pubescent than in* umbratus.

Head scarcely emarginate posteriorly ; *eyes* small, but a little larger and less flat than in *umbratus ; ocelli* very small and indistinct ; *frontal furrow* indistinct ; *funiculus* of antennae thicker than in *umbratus,* with joints broader than long. *Thorax* much less hairy and pubescent than in *umbratus. Scale* narrowest, and somewhat emarginate at apex, not so high as in *umbratus,* but higher than in *flavus ; gaster* with fewer and shorter hairs than in *umbratus. Tibiae* without outstanding hairs. *Long.* 3·5–4·5 mm.

♀ *Dark brown with mandibles, antennae, and legs reddish ; darker and much less hairy and pubescent than* umbratus.

Head as broad as thorax, but not so large, nor so emarginate posteriorly as in *umbratus*; *funiculus* of antennae thicker than in *umbratus* with joints not longer than broad. *Thorax* only slightly narrower than gaster, not so hairy nor so pubescent as in *umbratus*. *Scale* not emarginate at apex; *gaster* with fewer and shorter hairs than in *umbratus*. *Tibiae* without outstanding hairs. *Wings* infuscate at base, the colour slightly darker and reaching further across, and the *discoidal cell* smaller than in *umbratus*. *Long.* 6·5–8 mm. (6–8 mm. *teste André*.)

♂ *Blackish brown, funiculus of antennae and tarsi yellowish; slightly less robust, a little more shining, and less pubescent than* umbratus.

Head not quite so large as in *umbratus*; *mandibles* armed with five teeth, which are not as distinct as in *umbratus*; *frontal furrow* distinct; *eyes* without outstanding hairs. *Wings* as in the female, the colour extending a little further across, and the *discoidal cell* a little smaller than in *umbratus*. *Long.* 4·2–4·8 mm. (4–4½ mm. *teste André*.)

Original description of *Formica mixta* Nylander [Acta. Soc. Sc. Fenn. **2** 1050 (1846)] :—

"Simillima est *F. flavae*, differt autem: operaria pilis parvis sparsis corporis brevioribus, flagellis antennarum submoniliformibus (h.e. articulis paulo magis discretis), antennis ipsis, ut videtur, nonnihil majoribus longioribus; femina paulo minor, pilositate sparsa fere obsoleta, pilis minutis hinc inde sparsis, pubescentia microscopica cinerascenti-sericea aeque densa ac in *F. flava* et *umbrata*, oculis hirtulis, alis albescenti-hyalinis a basi fere ad medium dilute brunnescenti-tinctis, nervis pallidis, apicalibus omnino dilutis, stigmate cinerascenti-pallido, area discoidali trapezoidea dimidio minori h.e. proportione eadem ac in *F. nigra* ♀, anticis 8½ millimetra longis, squama subrectangulari supra integra, abdomine minori angustiori, pilis sparsis tantum minutissimis, multoque rarioribus, igitur longe nudiori (pube tamen sericea, ut dictum, in ambis aequali); mas corpore paulo minus nitido, pube sericea distinctiori, oculis parce microscopice hirtulis, lineola frontis impressa longitudinali distincta at transversa nulla, alis sicut in femina, nonnihil dilutius coloratis, area discoidali proportione ut in *F. nigra* ♂ (igitur dimidio minori quam in mare *F. umbratae*), anticis fere 5½ millimetra longis. Color alarum in specie praesente medium tenet inter *F. umbratum* et *F. flavam*, dilutior est quam in illa, obscurior quam in hac. His notis speciem eam solummodo indigitare valui. *F. rubra* Zett. Ins. Lapp. 450, 8 et Dahlb. mscrpt. probabiliter commixta est e speciebus tribus memoratis affinibus; sub hoc nomine etiam easdem tres a Cel. Dahlbom accepi. Maris varietas b., quae in Ins. Lapp. exponitur, verus est mas *F. flavae* nostrae; var. a. ibid. et *F. umbratae* et *flavae* pertinere videtur. At observationibus ulterioribus praesertim in vivo nidoque factis termini naturales, quibus circumscribuntur hae species, clarius elucebunt. Forsitan haud inconvenienter simul cum *F. nigra* propriam constituere possint subdivisionem, parvitate marium proportione feminarum suarum, inter alia signa, dignotam."

Habitat.

Acanthomyops mixtus ranges over North and Central Europe; Ruzsky records it from the Caucasus, Siberia, and Finland, and in North America it is represented by the var. *aphidicolus* Walsh, which according to Wheeler is the most abundant form of the *umbratus* group in the Northern States.

It is distributed in Britain as follows :—

Devon, S. : Bickleigh (*Bignell*)[15]; **Devon, N.** : Lundy Island (*Donisthorpe*)[26].

Somerset, N. : Long Ashton and Leigh (*Smallcombe*).
Dorset : Glanvilles Wootton (*Dale Coll.*).
Isle of Wight : The Landslip (*Dale Coll.*).
Hants, S. : New Forest (*Donisthorpe*)[32].
Kent, E. : Deal (*F. Smith*)[5]; Herne Bay (*Rothney Coll.*); Dover (*Donisthorpe*)[34].
Surrey : Richmond Park (*Dollman*)[20]; Mickleham (*Crawley* and *Donisthorpe*)[20]; Box Hill[27] and Weybridge (*Donisthorpe*)[20].
Essex, N. : Colchester (*Harwood*)[25].
Oxfordshire : Shotover Hill (*Hamm*); Horspath (*Cambridge Mus. Coll.*).
Bucks : Bourne End (*Best Gardener*)[25].
Suffolk, E. : Pakefield (*F. Smith*)[8].
Bedford : Sharpenhoe (*B. S. Williams*).
Gloucester, W. : Dursley (*Smallcombe*).
Glamorgan : Dinas Powis[28], Cwrt-yr-ala[25], Southerndown, Porthcawl, Cardiff, and Penarth (*Hallett*).
Lancs, S. : Formby (*Hallett*).
Edinburgh : Dalkeith Park (*Evans*)[22].
Linlithgow : Dalmeny Park (*Evans*).
Fife and Kinross : Isle of May (*Baxter* and *Rintoul*)[19]
Dublin : Killivey (*Stellfox*).
Wexford : Mount Garret Wood (*Phillips*).
Kilkenny : Graiquenamanagh Wood (*Phillips*).
Queen's Co. : Maryborough Wood (*Phillips*).
Galway, E. : Menlough (*Phillips*).

Acanthomyops mixtus was first recorded as British by Bignell, who discovered a colony at Bickleigh near Plymouth in September, 1881[15], but no further capture was published till 1908 when Grimshaw pointed out that the Misses E. V. Baxter, and L. J. Rintoul had taken specimens on the Isle of May in September and October, 1907[19]. Evans had taken a female *mixtus* on the Isle of May in September, 1888, and he found two nests there in 1910, and 1911[22], but no further records occur till the latter year[20].

The *Formica brunnea* F. Smith must be referred to *Acanthomyops mixtus*, as *A. brunneus* Latr., which lives under the bark of trees on the Continent, had not been found in Britain then.

Smith states that the *brunneus* of the Stephensian Collection was represented by a female *umbratus*, but that he had taken a single female of the true *brunneus* on the Deal sand-hills, in 1856[5].

Subsequently in his 1871 catalogue he sinks his *brunneus* as a synonym of *umbratus*, as also does Saunders, but as Smith describes the tibiae as being " without pile or pubescence " the specimen in question must have been *A. mixtus*.

Acanthomyops mixtus is not as abundant nor as widely distributed as *A. umbratus*; it occurs on heaths, in sandy places, but also in clearings and copses, in chalky districts, and seems to like the shade.

The habits are similar to those of *umbratus*—though it is a more active species—it lives a subterranean life, and nests under stones, at and in the roots of trees, in stumps and banks, and its nests penetrate deep into the ground.

Janet records a very large colony which he observed for five years in the garden of the Villa des Roses near Beauvais, which was nesting in the ground in a shady place, the earth being of a fine vegetable mould, with violets, etc., growing on it. He dug a hole and inserted his arm, and at the depth of thirty centimetres below the surface, after passing through a thickening of the soil, rendered spongy by the galleries of the ants, his hand reached a vast excavation dug out by the ants in the soft soil, overrun with roots. He noticed a gentle heat in this cavity[18].

In May, 1913, I found a number of colonies of *mixtus* at Box Hill[27], one or two were situated under stones—the flinty nature of the ground beneath rendering excavation impossible—one in and under a fallen bough, but the majority in the roots of dead juniper trees in thickets on each side of the valley. A number of species of ants occur in this valley, and their nests are nearly all situated on the side facing the east, but the *mixtus* nests were equally common on both sides. The ants had hollowed out the juniper roots, channelling them with galleries partly filled with brittle earthen cells, which on analysis were found to contain some fungus. Most of the ants, and their brood, were inhabiting these roots, but a number of workers also occurred in the flinty ground round about.

The marriage-flight takes place according to André from July to September[14], but the latter month seems to be the more usual time. Forel noticed the males and winged females leaving a nest together at Zurich on September 20th, 1870, at half-past four in the afternoon[13], Bignell observed a number of males and winged females on an old bramble stem at Bickleigh on September 2nd, 1881, the workers being on the ground below in great commotion[15], Evans captured two winged *mixtus* females with several winged *flavus* females on September 22nd, 1903, from a big swarm on the banks of South Esk, Dalkeith Park[22], and Misses Baxter and Rintoul took males, females, and workers on the Isle of May on September 10th, 11th, and 27th, and October 3rd, 1907[19].

Forel found a large number of winged females, no males being present, in a colony at Morges, on March 16th, 1868[13], which must have passed the winter in the nest.

On September 7th, 1913, I found a great number of males and winged females in a nest in a juniper root at Box Hill[27], in which some six or more young, freshly deälated, very active females also occurred. These young females may have already been fertilized in the nest, and as the females of this species do not lay till the following year, and as only one queen occurs in a nest, I would suggest that these young queens may leave the nests in the spring,

which would account for the isolated females found on roads, etc., at that time.

On March 7th, 1910, I found a deälated female walking on the heath at Weybridge[20], on February 17th, 1911, Dollman picked up a deälated female at large in Richmond Park[20] in March, 1911, Hallett captured a deälated female walking on the Millbrook road at Dinas Powis[28], and on April 22nd, 1911, Crawley and I took two deälated females on the road at Mickleham[20].

On August 11th, 1920, very many deälated females were seen all over the heath at Weybridge, and one winged individual was rescued from the clutches of a *Formica sanguinea* worker. One example was observed entering a hole in the sand which sheltered a colony of *alienus*. On digging into this nest six deälated *mixtus* females were found to have already established themselves in it[33].

As with *umbratus*, it is very rarely that the queen can be found in a *mixtus* colony, but on May 23rd, 1913, I had the good fortune to find the queen in two nests of this species[27]. The whole colony was exposed by pulling up the juniper tree bodily, and shaking the roots, in which the ants were situated, over a sheet, and in each of these two nests the colony consisted of a single deälated female, with the gaster considerably swollen, packets of eggs, young larvae and a large number of workers.

Young females of *A. mixtus* undoubtedly found their colonies in nests of *A. alienus*. As long ago as 1852, Schenck recorded that he once found a female *mixtus* in the earth with workers of *alienus*[2], but he did not draw any conclusion from this remarkable fact; myrmecologists appear to have overlooked Schenck's record and its importance.

On July 18th, 1912, I dug up a colony of *alienus* which was nesting in a sandy bank at Weybridge, and contained a deälated female *mixtus*, a number of *alienus* workers, and many large and small cocoons[25], but the most careful search failed to produce any other female, and no eggs were present. The colony was taken home and established in a " Janet " nest, and when all the cocoons had hatched, the large ones proved to be *alienus* winged females, and the smaller ones *alienus* workers. The *mixtus* female was very active, being exceedingly rapid in her movements, and very excited when first dug up. She laid eggs on August 7th, 1912, and was always treated as their queen by the *alienus* workers, who fed and cleaned her, and appeared to attend her brood.

Crawley and I have suggested, as this female laid eggs in 1912, that " we should judge this *L. mixtus* female, therefore, to have been adopted last summer "[23]—i.e. in 1911, but should this female have left the parent nest in the spring of 1912, and having found a nest of *alienus* have been accepted by the workers, it would account for her laying in the same year when accepted, but this would still be the year following fertilization.

On September 1st small larvae were present and a number were brought up, but as eventually only *alienus* workers were produced, the offspring of the *mixtus* female must have been devoured and the *alienus* workers themselves have laid eggs, the result obtained being the same as in Crawley's experiments with *umbratus* and *niger*.

On November 1st, the *alienus* workers killed some of their own winged females, and eventually destroyed and cut up all of them. The *mixtus* female unfortunately died on November 5th; she gradually lost the use of her legs, and in the end could only move her antennae, which she kept waving backwards and forwards, but to the last the *alienus* workers carried her about, cleaning and attending to her.

A number of larvae are now present in this nest, and a female *umbratus* as queen, but it is almost certain that these larvae will prove to be the offspring of the workers.

On August 11th, 1912, when I had the pleasure of Professor Wheeler's company, we found, at Weybridge again, another *mixtus* female, as queen in a nest of *A. alienus*[25].

These are instances in nature where the *mixtus* female has sought a nest of *alienus* in which to found her colony, and has been accepted by the workers. It is probable that either the latter then killed their own queen, if they possessed one, or the *mixtus* female accomplished this act herself.

The following myrmecophiles have occurred with *A. mixtus* in Britain :—

Coleoptera : *Homoeusa acuminata* Märk., and *Claviger longicornis* Müll.

Formicidae : *Myrmecina graminicola* Latr., *Stenamma westwoodi* West., and *Leptothorax nylanderi* Först.

Aphidae : *Schizoneura corni* F., and *Phorodon humuli* Schrnk.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic.

Araneina : *Cicurina cinerea* Panz.

Acarina : *Cillibano comata* Leon., *Trachyuropoda bostocki* Mich., *Antennophorus uhlmanii* Hall., *Laelaps* (*Cosmolaelaps*) *cuneifer* Mich., *Sphaerolaelaps holothyroides* Leon., and *Laelaps* (*Hypoaspis*) *myrmophilus* Berl.

Crustacea : *Platyarthrus hoffmanseggi* Brdt.

FORMICA Linné.

(Formica, ant.)

Type : **Formica rufa** L. (Lamk., 1801).

The circumpolar genus *Formica* comprises a number of species of robust and intelligent ants which live an open-air life, hunting insects and other prey, and attending plant-lice on trees and shrubs. They are said not to rear *Aphidae* in their nests, but I have not

infrequently found these insects domiciled with some of our Formicae, as will be seen later, when the different species are dealt with.

Many of these ants are very courageous and warlike—some of these possess the interesting habit of making slave-raids—whilst others are shy and cowardly, and are the ones chiefly exploited by the slave-makers.

The ants of this genus are rapid in their movements, have longer legs and stand higher on them than do the species of the genus *Acanthomyops*, and they do not follow each other in files over unknown territory. They use the eyes in finding their way, often leaving the trail and proceeding straight in the direction of the nest when a booty has been secured, and according to Wasmann can see resting objects on the ground at a distance of eight to ten centimetres.

These ants frequently carry their fellows beneath them ; the ant carried packs its antennae and legs close to its body and grasps the mandible of its carrier, doubling itself up with its gaster bent under the head of the other ant.

They secrete a large amount of formic acid—possessing twice as much in proportion to their size as do the larger ants of the genus *Camponotus.* With this poison they spray an enemy, and some of the species can eject it to a considerable distance.

The males are about the same size as the females, the latter being generally larger than the largest workers, and sometimes a great many queens occur in a single colony.

The workers sometimes lay eggs, especially in queenless colonies ; the queens lay eggs earlier in the year than do those of *Acanthomyops,* the larvae take much less time to develop, and are never present in the nests during the winter. The pupae are usually enclosed in cocoons of a pale buff colour, but are sometimes naked, and both will occur at the same time in the same nest.

The nesting habits are various, some species build large hillocks of vegetable refuse, some construct earth mounds, others nest in the ground, or under stones, and occasionally in tree stumps.

The swarming of these ants is seldom seen, and some species found their colonies in the normal, others in the abnormal, manner.

Their colonies are generally large, some species possess branch nests, and a great number of colonies in one area will all belong to the same vast community.

According to Wheeler *Formica* is " the most eurythermal " of the circumpolar genera *Stenamma, Myrmica, Lasius,* and *Formica* which are confined to the northern hemisphere, and it ranges in Europe, Asia, and North America from a latitude of 30° to 60° or 65°, and therefore nearly to the Arctic circle. In altitude the species range from sea-level to above timber-line, 12,000 to 12,500 ft.

Wheeler [Bull. Mus. Compar. Zoöl. **53** 385 (1913)] suggests that

North America is the original home of the genus ; he writes :—"If we divide the total number of the known Formicae (144) into Old and New World forms, we find that Eurasia possesses only fifty-two, whereas North America, though a much smaller land area, possesses nine-three species, subspecies, and varieties (one of the species, *F. fusca*, is counted twice, because it occurs in both hemispheres). This would seem to indicate that the latter continent must be the original home of the genus, especially as it possesses representatives of all the Eurasian groups of species besides two peculiar to itself. Unless we accept the view that the genus arose in the polar region during Mesozoic times and radiated its species out into Europe, Asia, and North America, we must suppose that Eurasia has received its species by immigration from the Nearctic region. That the latter view is the more probable is shown by a glance at the distribution of the forms in America. At least thirty-nine of our ninety-three forms, or nearly 42 per cent, occur in Colorado and the adjacent portions of New Mexico. Not only are these two states thus abundantly supplied with species, subspecies, and varieties but the colonies of the individual forms are unusually numerous and flourishing on the mountain slopes of this territory. We may therefore regard the southern ranges of the Rocky Mountains in the United States as the centre of origin of the genus and of the dispersal of species to other portions of North America."

Five species of *Formica*, some of which are closely related to existing forms, have been described from the Baltic amber.

Lamarck [Syst. An. sans. Vert. 268 No. 124 (1801)] adopts *F. rufa* L. as the type of *Formica* L.—Latreille [Cons. Gen. Crust. Ins. 311 No. 441, 437 (1810)] gives *herculeana* (L.) F., and *rufa* L., as the types, and the latter was definitely cited as the type by Curtis [Brit. Ent. 16 expl. Pl. 752 (1839)]—Westwood [Mod. Class. Ins. **2** Syn. Gen. 83 (1840)] quotes Curtis, but cites *fusca* L., as type. In 1879 Girard [Traité Élém. Ent. **2** 1011 (1879)] also states that *rufa* is the type, as does Bingham [Faun. Brit. India Hym. **2** 333 (1903)] —Wheeler [Ann. New York Acad. Sc. **21** 164 (1911)] adopts the last citation, but subsequently [Ann. New York Acad. Sc. **23** 79 (1913)] attributes the fixing of the type to Girard, overlooking the earlier citations.

Wheeler in 1913 divides *Formica* into five groups—*sanguinea*, *exsecta*, *rufa*, *microgyna*, and *fusca* [Bull. Mus. Compar. Zoöl. **53** 381 (1913)], and Forel, when commenting on this arrangement, gives the subgeneric name of *Raptiformica* to the *sanguinea*-group, designating *sanguinea* Latr., as type, and *Serviformica* to the *fusca*-group, with *fusca* L., as type [Ann. Soc. Ent. Belg. **57** 361 (1913)].

☿ *Head* cordate ; *clypeus* large, trapezoidal, convex, carinate ; *frontal carinae* wide apart, subparallel, usually slightly diverging posteriorly ; *frontal area* triangular, distinctly defined, pointed posteriorly ; *frontal furrow* more

or less distinct; *mandibles* broad, triangular, terminal border dentate; *maxillary palpi* six-jointed (rarely five-jointed), fourth joint slightly longer than fifth; *labial palpi* four-jointed; *antennae* twelve-jointed, *funiculus* with joints gradually and slightly thickened towards the apex, but not forming a club; *ocelli* always present and distinct. *Thorax* narrower than head; *pronotum* rounded; suture between pronotum and mesonotum distinct; *mesonotum* rounded, suture distinct, and more or less deeply constricted, between mesonotum and epinotum; *epinotum* when seen in profile angled or rounded. *Petiole* furnished with an erect scale, which is compressed posteriorly and anteriorly; *gaster* short, globose.

♀ Characters, except thorax, as in the ☿; *wings* ample, *fore-wing* with one *discoidal cell*, and one *cubital cell* which is always closed.

♂ *Head* triangular; *clypeus, frontal area* and *palpi* as in the ☿; *frontal carinae* very short and indistinct; *mandibles* narrow, somewhat flat, terminal border short, armed with one or five teeth; *antennae* thirteen-jointed, *funiculus* with first joint not broader than the rest, shorter than the second. *Petiole* with scale thicker and less compressed than in the ☿ and ♀, often emarginate at apex; *gaster* flat and depressed above; *external genital organs* large. *Wings* as in the female.

Ovum: White, long oval, distinctly longer than broad.

Larva: Pale yellowish white, long, narrow, and curved anteriorly; head considerably narrower than the rest of the body; segments well defined, transversely striate, and gradually increasing in width till just before the distal end. The whole body covered with short straight hairs of equal length, which appear to be bifid at the apex, and are more abundant on the younger larvae.

Pupa: Usually enclosed in pale buff cocoons, but sometimes naked. The pupae do not acquire the complete adult coloration before they emerge.

Original description [Linnaeus Syst. Nat. Ed. 10 **1** 343, 579 (1758)]:—

"218 Formica. *Aculeus* obsoletus. *Alae* neutris nullae!" (p. 343).

"218 **Formica.** *Squamula* erecta thoraci abdominique interjecta.
Aculeus Feminis & Neutris reconditus.
Alae Maribus & Feminis; sed Neutris nullae" (p. 579).

Table of the Species.

☿

1	Clypeus not emarginate	2
–	Clypeus emarginate –	4 *sanguinea* Latr.
1	Head deeply excised posteriorly	3 *exsecta* Nyl.
(1)	Head not excised posteriorly –	3
3	Body robust; head evidently broader than thorax, in the largest individuals not, or scarcely, longer than broad; scale hexagonal; gaster much broader than the thorax	4
(2)	Body more slender, head only a little broader than thorax, in the largest individuals longer than broad; scale rounded; gaster not much broader than thorax –	6
4	Gaster brown or black, often more or less red at the base; eyes without or with less pronounced hairs	5
(3)	Gaster black; eyes with pronounced hairs – – – – – – – –	2 *pratensis* Retz.
5	Head long and narrow, cheeks straight; thorax more slender	*rufa* v. *alpina* Sant.
(4)	Head short, cheeks more rounded; thorax more robust –	1 *rufa* L., and *rufa* v. *rufo-pratensis* For.

6 Body opaque 7
(3) Body shining — — — — — — — — — — — — — — — — — — 7 *picea* Nyl.
7 Body black . . . . 5 *fusca* L.
(6) Body at least in part red or brown — — — — — — — — — — — — — — 8
8 Thorax chiefly dark in both large and small individuals . . . . *fusca* v. *glebaria* Nyl.
(7) Thorax largely red in the larger individuals — — — — — — — — — — 9
9 Thorax red in largest individuals only, without outstanding hairs . . . . *fusca* v. *rubescens* For.
(8) Thorax red generally, only infuscate in small individuals, with outstanding hairs . . . . 6 *rufibarbis* F.

♀

1 Clypeus not emarginate 2
– Clypeus emarginate — — — — — — — — — — — — — — — — *sanguinea* Latr.
2 Head excised posteriorly . . . . *exsecta* Nyl.
(1) Head not excised posteriorly — — — — — — — — — — — — — — — — 3
3 More robust; head broader than thorax; thorax higher, more rounded above; gaster shorter, more spherical, much broader than thorax . 4
(2) Less robust; head not, or scarcely broader than thorax; thorax not so high, flatter above; gaster longer, not so much broader than thorax – 6
4 Head long, narrow, cheeks straight . . . . *rufa* v. *alpina* San.
(3) Head broad, cheeks more rounded — — — — — — — — — — — — — — 5
5 Gaster smoother and shining, scarcely pubescent . . . . *rufa* L.
(4) Gaster duller, distinctly pubescent — — — — — — — — — *pratensis* Retz.
6 Body all black 7
(3) Body in part red — 8
7 Less shining, more punctured and pubescent and less hairy . *fusca* L.
(6) More shining, less punctured and pubescent, more hairy — — — — *picea* Nyl.
8 Thorax largely red; outstanding hairs on thorax more abundant and distinct . . . . *rufibarbis* F.
(6) Thorax mostly black; outstanding hairs on thorax less abundant and less distinct — 9
9 Epinotum almost entirely red . . . . *fusca* v. *rubescens* For.
(8) Epinotum black or partly black — — — — — — — — *fusca* v. *glebaria* Nyl.

♂

1 Mandibles armed with four, or five, teeth; clypeus emarginate . . . . *sanguinea* Latr.
– Mandibles not armed with four, or five, teeth; clypeus entire — — — — 2
2 Head excised posteriorly . . . . *exsecta* Nyl.
(1) Head not excised posteriorly — — — — — — — — — — — — — — — — 3
3 Robust, broad; body much more hairy; eyes hairy 4
(2) More slender, narrower; body less hairy; eyes without hairs — — — — 5
4 Slightly more robust; body and eyes more hairy . . . *pratensis* Retz.
(3) Slightly less robust; body and eyes less hairy — — — — — — — — *rufa* L.
5 Gaster shining 6
(3) Gaster dull — 7
6 Thorax with more, and longer, hairs and pubescence; gaster less strongly punctured, and with longer, and less close, pubescence . . *picea* Nyl.
(5) Thorax with scarcely any hairs or pubescence; gaster more strongly punctured, and with shorter and closer pubescence — — — — — *fusca* L.
7 Scale deeply emarginate . . . . *fusca* v. *rubescens* For.
(5) Scale widely but not deeply emarginate — — — — — — — — — — — — 8
8 Legs mostly red; outstanding hairs on thorax shorter and sparser . . . . *fusca* v. *glebaria* Nyl.
(7) Femora and tarsi usually blackish; outstanding hairs on thorax longer and thicker — *rufibarbis* F.

Formica rufa L.

[" The Hill Ant " Gould Account English Ants (1747)[1].] *Formica rufa* Linnaeus Syst. Nat. Ed. 10 **1** 580 (1758)[2]. *Formica dorsata* Panzer Faun. Ins. Germ. **54** 1 (1798)[3]. *Formica rufa* Latreille HN. Fourmis 143–150 (1802)[4]. *Lasius emarginatus* Fabricius Syst. Piez. 416 (1804) ♂[5]. [" La fourmi fauve dos rouge " Huber Mœurs Fourmis (1810)[6].] *Formica rufa* Hill Mag. NH. **6** 476 (1833)[7]; Conway Mag. NH. **7** 266–267 (1834)[8]; Kirby Proc. Ent. Soc. Lond. **1** XXV (1835)[9]; Lees Nat. **1** 154 (1837)[10]; Clarke Mag. NH. (n.s.) **2** 393 (1838)[11]; Zetterstedt Ins. Lappon. **1** 448 (1838)[12]. *Formica obsoleta* Zetterstedt Ins. Lappon. **1** 449 (1838)[13]. *Formica lugubris* Zetterstedt Ins. Lappon **1** 449 (1838)[14]. *Formica rufa* Curtis Brit. Ent. **16** expl. Pl. 752 (1839)[15]; F. Smith Trans. Ent. Soc. Lond. **3** 151–154 (1842)[16]; Plant Zool. **2** 473–474 (1844)[17]; Nylander Acta. Soc. Sc. Fenn. **2** 902 1047 1059 (1846)[18]. [" The Large Wood Ant " Daniell Zool. **5** 1931 (1847)[19].] *Formica rufa* Nylander Acta Soc. Sc. Fenn. **3** 26 (1849)[20]. *Formica rufa* v. *major* Nylander Acta. Soc. Sc. Fenn. **3** 29 (1849)[21]. *Formica rufa* Förster Hym. Stud. **1** 13–15 (1850)[22]. *Formica polyctena* Förster Hym. Stud. **1** 15 (1850)[23]. *Formica truncicola* Förster Hym. Stud. **1** 21 (1850) ☿[24]. *Formica rufa* Schenck Jahrb. Ver. Naturk. Nassau **8** 23–25[25] 136[26] (1852). *Formica polyctena* Schenck Jahrb. Ver. Naturk. Nassau **8** 25 137 (1852)[27]. *Formica piniphila* Schenck Jahrb. Ver. Naturk. Nassau **8** 28 138 (1852)[28]. *Formica rufa* F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 100 (1855)[29]; Mayr Verh. Zool. Bot. Ver. Wien **5** 328–331 (1855)[30]; F. Smith Cat. Brit. Foss. Hym. 4 (1858)[31]. *Formica apicalis* F. Smith Cat. Hym. Brit. Mus. **6** 49 (1858)[32]. *Formica herculanea* Warner Sc. Gossip **1871** 198[33]. *Formica rufa* Buchanan-White Scot. Nat. **1** 216–222 258–263 (1872)[34]. *Formica rufa* r. *rufa* Forel Denkschr. Schweiz. Ges. Naturw. **26** 52[35] 203–204[36] 219[37] 408[38] (1874). *Formica rufa* Forel Bull. Soc. Vaud. Sc. Nat. **14** 59–60 (1875)[39]; Lubbock Mo. Mic. Journ. **18** Pf. 192 : 3·4·7 (1877)[40]; Bignell Ent. Mo. Mag. 16 267 (1880)[41]; Parfitt Trans. Devon Assn. Sc.-Art. **12** 513 (1880)[42]; Saunders Trans. Ent. Soc. Lond. **1880** 204[43]; Er. André Spec. Hym. Europe **2** 184 (1881)[44]; Lubbock Ants, Bees, Wasps 15 (1882)[45]; Collett Ent. Mo. Mag. **20** 42 (1883)[46]; Matthews Ent. Mo. Mag. **20** 209–210 (1884)[47]; Darwin Life and Letters **3** 192 (1887)[48]; Bowman Sc. Gossip **1889** 32–34[49] 198–200[50]; Dalla Torre Cat. Hym. **7** 206 (1893)[51]; Farren-White Ants' Ways 73[52] 202[53] 231[54] (1895); Saunders Hym.-Acul. 20 (1896)[55]; Ent. Mo. Mag. 32 161 (1896)[56]; Bignell Ent. Mo. Mag. **33** 141[57] 183[58] (1897); Morley Ent. Mo. Mag. **33** 158 (1897)[59]; Janet C. R. Acad. Sc. Paris 130 (1898)[60]; D. Sharp Camb. NH. Ins. **2** 148 (1899)[61]; Yung Arch. Sc. Phys.-Nat. **10** 46–56 (1900)[62]; Poulton Proc. Ent. Soc. Lond. **1901** X XIII[63]; Donisthorpe Proc. Ent. Soc. Lond. **1901** XIII[64]; Wheeler Bull. Amer. Mus. NH. **20** 347–375 (1904)[65]; Wasmann Biol. Centralb. **25** 194–199 (1905)[66]: Tijds. Ent. **48** 214–219 (1906)[67]; Joy Ent. Rec. **20** 19 (1908)[68]; Donisthorpe Ent. Rec. **20** 281–283 (1908)[69]; Trans. Leicester Lit.-Phil. Soc. **12** 221–222 (1908)[70]; Wasmann Biol. Centralb. **28** 258–260 (1908)[71]: Arch. Tri. Inst. Grand-Ducal Luxemburg **4** 3–12 (1909)[72]: Naturwiss. Wochenschr. **8** 407 (1909)[73]; Wheeler Journ. New York Ent. Soc. 17 172–176 (1909)[74]. [" The Large Wood Ant " Weiss New Phytol. **8** 81–89 (1909)[75].] *Formica rufa* Standen Lancs. Nat. **2** 190 (1909)[76]. *Formica rufa rufa* Emery Deutsch. Ent. Zeitschr. 185 (1909)[77]. *Formica rufa* Donisthorpe Trans. Ent. Soc. Lond. 1910 143–144[78]: Ent. Rec. **22** 82–83 (1910)[79]; Wheeler Ants 654 (1910)[80]; Donisthorpe Ent. Rec. **23** 10 (1911)[81]: Trans. Ent. Soc. Lond. **1911** 175–178[82]: Entom. **44** 390 (1911)[83]: Ent. Rec. **24** 7–9 (1912)[84]: Marvels of Universe **27** 1099–1104 (1912)[85]; Evans Scot. Nat. **1912** 105[86]; Rüschkamp Biol. Centralb. **32** 213–216 (1912)[87]; Wasmann Zeitschr. Wissens. Zool. **101** 113 (1912)[88]; Donisthorpe Ent. Rec. **25** 65 (1913)[89]; Crawley and Donisthorpe Int. Ent. Cong. Oxford **1912** **2** 37–47 (1913)[90]; Brun Zeitschr. Wissens. Insektenbiol. **9** 15–17 (1913)[91]; Kutter Biol. Centralb. **33** 703–707 (1913)[92].

Formica rufa rufa Wheeler Bull. Mus. Compar. Zoöl. **53** 425–427 (1913)[93]. *Formica rufa* Donisthorpe Ent. Rec. **26** 40 (1914)[94]; Morice and Durrant Trans. Ent. Soc. Lond. **1914** 430 (1915)[95]; Stainforth Nat. **1915** 393[96]; Schmitz Jaar. Natuur. Genoots Limburg **1915** 83[97]. *Formica (Formica) rufa rufa* Emery Bull. Soc. Ent. Italiana **47** 255 (1916)[98]. *Formica rufa* Donisthorpe Ent. Rec. **31** 2 23 (1919)[99]: **33** 22 (1921)[100]: **35** 6 (1923)[101]: **36** 52 (1924)[102]; Lomnicki Bull. Ent. Pologne **3** 26 (1924)[103]; Donisthorpe Ent. Rec. **37** 3 (1925)[104]. *Formica (Formica) rufa* Emery Gen. Ins. **183** 253 (1925)[105].

Zetterstedt, p. 450 sp. 8, writes " *F. rufa* "; this is a misquotation, No. 1725 L. Fn. Suec.=*Formica rubra* L. Zetterstedt correctly refers to *rufa* on p. 448 sp. 3[12].

☿ *Lighter or darker brick-red; front, vertex, antennae, legs, sometimes a line down the centre of clypeus, often a spot on the pronotum, which does not, however, reach the posterior border, and occasionally another on the mesonotum dark brown, or blackish brown; gaster blackish or blackish brown, more or less red at the base.*

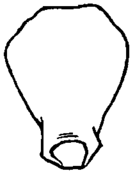


Fig. 88. Scale of *Formica rufa* ☿.

Head about as long as broad, not emarginate posteriorly, lateral border somewhat rounded; *clypeus* distinctly carinate, not emarginate anteriorly; *frontal area* shining, smooth, or slightly punctured; *mandibles* armed with eight teeth; *antennae* stout, *funiculus* with apical joints longer and slightly narrower than penultimate joints; *eyes* without, or with indistinct hairs. *Thorax* narrower than head and gaster; *pro-* and *mesothorax* convex; strongly constricted between mesothorax and epinotum; *epinotum* seen in profile rounded but evidently angled. *Scale* large, broad, hexagonal, sometimes emarginate at apex, bare, or with a few hairs; *gaster* large and broad, rather dull, with very short fine pubescence, and suberect hairs more abundant than on the head or thorax. *Legs* long, robust, furnished with only decumbent pubescence, except the usual bristles. *Long.* 4–9·5 mm.

♀ *Red, vertex of head, clypeus, thorax above, except anterior portion of pronotum, some spots at the insertion of the wings, and epinotum; gaster except base, antennae, and legs except base of femora, black or blackish brown.*

Head as in ☿. *Thorax* robust, high. *Scale* without hairs; *gaster* shining, more or less smooth, without suberect hairs, and with pubescence wanting, or very scanty. *Legs* with only the usual bristles, and with very short and sparse decumbent pubescence. *Wings* somewhat infuscate, with brownish yellow pterostigma and veins. *Long.* 9·5–12 mm.

♂ *Black; genitalia reddish yellow; legs reddish, or dark brown with knees lighter.*

Head rather small, triangular, not excised posteriorly; *clypeus* carinate, convex, not emarginate anteriorly; *mandibles* only toothed at apex; *frontal area* dull, slightly punctured, or simply alutaceous; *eyes* with sparse hairs.

Thorax with rather abundant erect black hairs; *mesonotum* rugose and dull, with large, scattered, pit-like punctures; *scutellum* more shining. *Scale*

thick, emarginate at apex, furnished with some scattered long hairs ; *gaster* shining above, with erect hairs scarce, or wanting, and scanty, not close, pubescence. *Wings* as in ♀. *Legs* without suberect hairs, except the usual bristles. *Long.* 10–11 mm.

Original description of *Formica rufa* Linnaeus [Syst. Nat. Ed. 10 **1** 580 (1758)] :—

" F. thorace compresso toto ferrugineo, capite abdomineque nigris.
Fn. suec. 1020 Formica rufa.
Raj. ins. 69. Formica media rubra.
Habitat in Europae *acervis acerosis sylvaticis; in America septentrionalii. Kalm.*"

Habitat.

Formica rufa ranges over North and Central Europe as far south as the Pyrenees and the southern slopes of the Alps, occurring in the Caucasus and Siberia, and in the mountains only in South Europe[93]. In Britain it is widely distributed in England, but in Scotland its range is peculiar, and in Ireland it is scarce. Buchanan-White writes in 1872 :—" It does not appear to occur in Scotland south of a line beginning at Arran in the South-West, and then passing in a North-Easterly direction along the line of the Grampians, through Ben Lomond, Dunkeld, and Dee-Side, and reaching the East coast probably somewhere in Aberdeenshire "[34]. It is certainly very remarkable that it does not appear to occur between Dumbarton and Stirling, and the English border. It has been found in Ireland in Armagh, Wicklow, Wexford, East Galway, Waterford, and Kerry, and in Wales in Glamorgan, Brecon, Merioneth, Carnarvon, Denbigh, and Anglesey. I have no records in England for East Cornwall, North Somerset, South Wilts, Herts, West Suffolk, West Norfolk, Bedford, Hunts, Northampton, East Gloucester, North Lincoln, South Lancashire, South, East, and North-West Yorks, Westmorland, and in Scotland, north of the Forth, for Fife and Kinross, North Perth, Kincardine, North Aberdeen, Banff, West Ross, West Sutherland, and Caithness.

Formica rufa is perhaps the most generally known ant in Britain, and has been called the " Wood Ant," " Hill Ant," " Fallow Ant," " Horse Ant," and in Germany, " Waldameise." D. Sharp refers to it as the " Red-ant "[61], but this is the name used for *Myrmica rubra.*

It is a hardy, fierce, and courageous species, being very strong, and able to lift very heavy weights in proportion to its size, and living chiefly an open-air life.

Its movements are abrupt, and it shows a want of individual initiative, single ants appearing to be rather stupid, as they will pass close by an object of which they are in search over a dozen times.

In warfare they attack in serried masses, not exhibiting the

strategy of *F. sanguinea*, nor sending out small troops to execute flank movements. They do not persistently pursue a flying foe, but endeavour to kill as many enemies as possible at once, and do not hesitate to sacrifice themselves for the common good in defence of their nests.

Warner states that in descending from a tree these ants drop from leaf to leaf to save themselves trouble in reaching the ground[33], but this is by no means always the case.

They are indefatigable in working; Plant says they continue from sunrise till an hour after sunset[17], but Kirby pointed out that they are at work at midnight[9], and this I have often noticed in the observation-nests I have kept of this species.

Sometimes they delight to bask in the sun, resting on a leaf, or on the top of the nest, and occasionally individuals will play together, chasing each other, rolling over, and pretending to fight.

These ants very frequently carry their fellows, and this act was mistaken by Hill[7], and other early writers, and even by Bignell[41], as an instance of making war, the carriers being supposed to have taken the carried prisoners.

Matthews describes a combat between two *rufa* colonies, which were situated on opposite sides of a ditch at Skellingthorpe, Lincs, on June 25th, 1850, when large numbers of both were said to have been destroyed, the whole of the space in the ditch being literally covered with the dead bodies of the combatants, which in some places lay more than an inch deep[17].

This, however, is very unusual, for, as will be seen later, the nests in one area belong to the same large community. I have seen large numbers of dead ants in a cart-track near a large nest of *F. rufa* in Haye Woods near Knowle, which had been killed by a beetle, *Myrmedonia humeralis*. This beetle occurred in every crack and under every dead leaf in the cart-track, and every here and there little heaps of dead ants were to be seen, and these kept being added to by the Myrmedonias with specimens they had slain, thousands of the ants being killed[69].

Bowman says that the sense of hearing in this species is very acute; he instances the "clapping of hands"[49] and the "buzzing of a fly"[50] being noticed at once, and he gives some not very convincing experiments to prove his point. Clarke also mentions that when he kicked a fir tree on which were a number of *rufa* workers, instantly every vagrant ant suspended its operations and leant forward with the antennae porrect as though they were listening to discover the cause of the annoyance[11]. These cases do not illustrate hearing in our sense of the word, but rather reaction to material vibrations. I have tested *F. rufa* (and other ants) in captivity with the Galton-Edelmann whistle, up to its highest range, but the ants never appeared to notice anything.

F. rufa recognizes its fellows both from the same nest and from the same community, after having been separated for long periods.

On April 2nd, 1901 (not "1907"[78]), I established a nest of *Formica rufa*, from Oxshott, in my study, containing twelve females and many workers, etc., and on April 12th I brought home from the same nest at Oxshott some more females and workers and introduced them into my observation-nest, when they were at once recognized and received with pleasure, the females being cleaned and led into the nest. On April 26th, I brought home a female and some workers from another nest at Oxshott, far removed from the first nest, and these also were well received by the ants in the observation-nest. I have also been in the habit of obtaining ants in the spring from the same *rufa* nests from which I had previously taken specimens to form observation-nests at home, and introducing them into the latter. I extract the following from one of my note-books—"May 19th, 1907. Took part of a nest of *F. rufa* at Weybridge"; then later on, "April 7th, 1908. Got some more débris from the same nest at Weybridge, 4 ♀♀, ☿☿, etc.; ants all well received."[78]

As an instance of tenacity of life, an experiment made by Janet may be mentioned in which a *rufa* worker lived without a head for twenty-nine days[60].

This species nests in woods in shady places, in clearings, and on the borders of woods and forests—but also in the interior—on heaths and commons, but never far from trees, being more generally associated with fir trees, though it also occurs in oak, birch, and other woods. Forel states that in the Alps it is intimately connected with the fir trees, occurring as high as the last of these, but never higher[37].

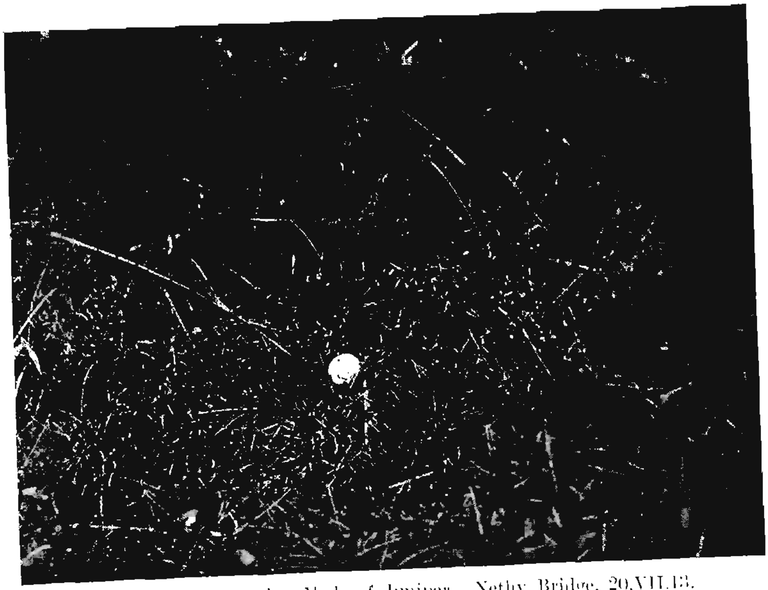
F. rufa usually avoids the neighbourhood of human habitations, but will enter gardens in search of its prey and other food.

Its nests principally consist of the well-known mounds or hillocks forming a conical structure on the ground, covering an earth mound crater at the base, these structures being built up of pine needles, bits of stick, leaves, dried grass, or any other vegetable refuse, small shells, pebbles, etc.

In oak woods they are chiefly composed of oak twigs; at Nethy Bridge I have seen a nest formed entirely of juniper leaves and twigs, at Weybridge of bracken, grass, and birch, and in Parkhurst Forest I found a small nest chiefly composed of small pebbles, which gave it a rather strange appearance—the ants must have experienced considerable difficulty in carrying some of the larger stones, and placing them in position on the top of the hillock[81].

In Dean Forest, where this ant is abundant, its nests were found to be constructed of grass; holly twigs and leaves; and beech buds; respectively[102].

Nest of *Formica rufa*. Bournemouth, VIII.14. (Hamm.)

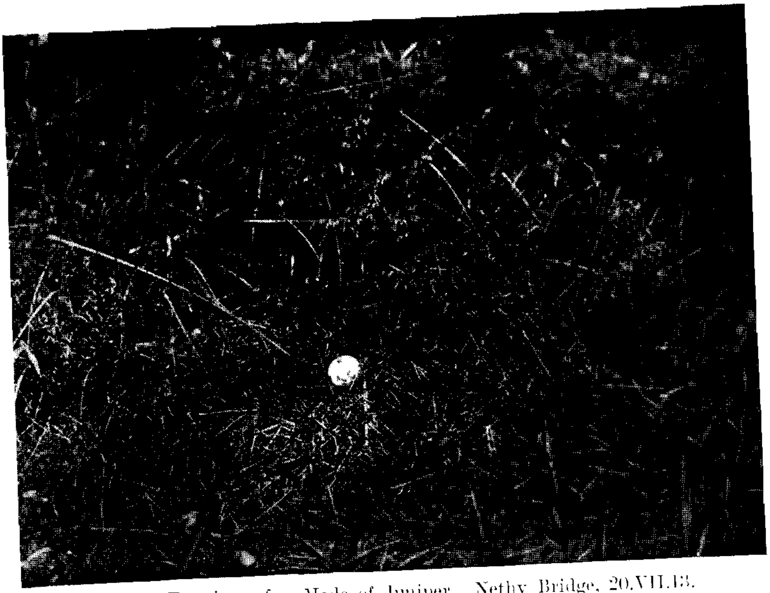


Nest of *Formica rufa*. Made of Juniper. Nethy Bridge, 20.VII.13.
(The white disc is a half-crown to show the size of the nest.)

Face page

PLATE XIII.

Nest of *Formica rufa*. Bournemouth, VIII.14. (Hamm.)



Nest of *Formica rufa*. Made of Juniper. Nethy Bridge, 20.VII.13.
(The white disc is a half-crown to show the size of the nest.)

Face page 290.

In Northumberland and Scotland these ants collect large quantities of yellow resin—"ant-amber"—from the fir trees; I have seen nests full of it, and Latreille states that in Sweden the inhabitants gather the resin of juniper trees accumulated by *F. rufa* in its nests and burn it to purify the air[4].

Under the hillock is a large central chamber, which is connected by galleries with other underground chambers and other parts of the nest. Numerous openings all over the structure form entrances to the nest; these are closed by the ants at night with twigs, etc., laid across each other, and sentinels are always stationed at these entrances. The habit peculiar to this ant and its allies of building hillocks shows their descent from a more ancient Arctic life, as the heaping up of these mounds better attracts the rays of the sun and also concentrates the warmth in the nest.

Bignell in describing a large nest near Plymouth which he had known for ten years, and which he stated would measure forty feet in circumference at its base, writes :—"The extreme west side of it has been given up in consequence of receiving the beat of the weather"[58]—but the real reason for this was that, as we have before shown, ants prefer to face the east, and they would continue to build towards the east to obtain the most benefit from the sun.

The height and size of these hillocks varies according to the age of the nest, their situation and whether they have been disturbed or not. Latreille[4], Daniell[19], and Bignell[41] record nests three feet high, Farren-White says he has found them full forty feet in circumference[53], Forel gives one metre high and two metres in diameter, and Buchanan-White mentions nests four feet in height and twenty-five feet in circumference in Scotland[34], but I have seen some narrow cone-shaped nests quite five feet high at Aviemore.

Joy records *rufa* nests situated in very thick undergrowth near Bradfield. He writes :—"The wood had been cleared two years before and small fir trees had been planted. It had not, however, been 'grubbed' and the stumps of the trees and briars were growing freely. It seemed rather a hopeless place to look for nests, but the keeper pointed out to me that when a nest was placed in thick undergrowth, the latter was evidently well nourished, as it was taller than the surrounding herbage and of a darker green. After this I had no difficulty in locating nests from some yards' distance, although they were always quite hidden from view; but sometimes they proved to be uninhabited"[68].

The reason why the undergrowth was better nourished in the neighbourhood of the nests is probably that the soil was loosened by the underground tunnels of the ants, which would have somewhat the effect of deep ploughing, and also because the vegetation would be freed from any caterpillars, etc.

When a *rufa* hillock has been overthrown, or disturbed, the

workers soon build it up again, but if it is continually interfered with the ants will move to another situation near by.

Morley asks :—" Why this species periodically deserts its nests in the late autumn, and is found to possess a brand-new one, with all parts complete, some twenty yards or so distant the next spring ? "[59]—but this is certainly not the usual habit of these ants. If they find for some reason that the situation they occupy is unsuitable, they will move, perhaps several times, and then they often take part of the nest itself with them. I have seen the ants of this species at Buddon Wood moving the whole nest to a spot near-by, the pupae and entire contents of the nest, and most of the nest materials being carried bodily away, and many of the workers were carrying their fellows.

On the other hand, a nest in a suitable situation will, if undisturbed, remain on the same spot for a great many years—Conway pointed out in 1834 that the old habitations still remain in the same place from year to year[8], Forel has known a nest (of *F. pratensis*) *at Vaux for over forty years, Charles Darwin in a letter to Forel* mentions that an old man of eighty noticed one very large *rufa* nest in the same place ever since he was a boy[18], and I have known another at Weybridge for over twenty years.

F. rufa occasionally makes its nests in stumps and posts, carving out chambers in the wood, these stumps being often wholly or partly covered with vegetable refuse.

Forel mentions a curious nest he found near Munich, which was situated at the foot of two posts two metres eight centimetres high, belonging to a balustrade bordering a thick forest. The ants had heaped up materials to the top of one of these, and the interior of the post was entirely sculptured out[39].

On June 29th, 1918, I observed an interesting *rufa* nest in the New Forest, which called to mind the one just mentioned. It was situated all round a gate-post, and the materials of the nest were piled right up to and on the top of the post, and the space between the post and the gate was also filled with the same. Part of the post was hollow, and this and the cracks in the post were also packed with pine needles, bits of stick, etc., etc., and a continuous stream of ants kept bringing up further materials.[99]

I have seen *rufa* colonies at Bagshot situated in tree stumps on a high bank ; no materials were present over the stumps except a quantity of sawdust which the ants had accumulated in boring out their galleries in the stumps. A single colony may have a number of nests connected with one another by runs, paths, and tracks, thus forming a vast community, or ant-town, over a large area.

A certain proportion of a colony will emigrate and form a new nest with one or more queens, and a colony thus split is enabled to spread in the immediate vicinity where the conditions are favourable

and the same, rather than to send off swarms to less favourable localities.

A number of tracks, or open streets, extend to some distance from a nest—Forel gives eighty to one hundred metres[36]; these tracks often lead to trees infested by Aphidaes, or some other hunting ground, and the ants sometimes cut down the vegetation to clear a path.

Bignell says "that a new colony within a hundred yards would, I feel certain, not be permitted by the old one"[58], but now that we know how *rufa* founds a new colony, as will be shown later, it is clear that such a contingency would not arise.

In 1880 he records what he took to be a raid by a large colony on a smaller one two hundred feet away, the ants of the former carrying those of the latter by the mandibles[41], but this was certainly a case of a branch nest, and no ant would allow a stranger to carry it quietly away from its nest in the manner he describes!

On June 12th, 1911, I observed a branch nest of *rufa* in the Black Wood at Rannoch. Two nests were found to be in connection one hundred and twenty-eight yards apart, one a large mound, about seventy-two inches in diameter and fifty-four inches in height, a few yards below the path, and the other a small hillock about the same distance from the path on the other side of it. The ants were going backwards and forwards along the path to the two nests, food being carried to the large nest, but the ants were carrying their larvae from the large nest to the smaller one. A deälated female was trying to get to the smaller nest; though often stopped by the workers, she persisted and gradually won her way to it. Some winged females were up on the top of the large mound[84].

Colonies of these ants comprise a very large number of individuals —for a single nest Farren-White suggests ten thousand[52], and Forel estimated (for a *pratensis* nest) ninety thousand to one hundred and fifty thousand. Yung, who actually counted the inhabitants of five *rufa* nests, gives for the one with the fewest ants—a nest 0 m. 45 high and 0 m. 95 in diameter, 47828, and for the one with the largest number—a nest 0 m. 65 high and 1 m. 40 in diameter, 93694, and he thinks, making all due allowances for possible errors, that a single nest would not contain much over one hundred thousand ants[62].

Formica rufa secretes a large amount of formic acid (HCOOH), the *Spiritus formicarum*, and is the most capable of ejecting it into the air in defence of the nest, etc.; these ants partly paralyse their prey with acid discharges, and spray the liquid into a wound caused by their mandibles. When alarmed, or enraged, the workers stand up on the tips of their feet, with the gaster bent between their legs, and the acid is ejected to a considerable distance from the anal aperture. Forel says it is shot into the air to a height of five

to six decimetres[37], Daniell[19] and Conway[8] give six and three inches respectively, but they both inaccurately state it is ejected from the mouth, André sixty centimetres[44], Escherich $1\frac{1}{4}$–$1\frac{1}{2}$ m., and Lubbock says a hand held as high as eighteen inches above the nest will be covered with acid[45]. I have noticed it shot by these ants to a distance of from six to twelve inches.

Latreille mentions that the people in Sweden employed this acid to give a taste of lemon to cream[4], and Schenck says it was used in Germany in baths as a cure for gout and rheumatism[25].

The fumes of this acid are so pungent as to induce coughing and take one's breath away if the head be held over a disturbed nest of this species.

It is also very corrosive, and Latreille pointed out that it produces pustules on the skin such as are produced by stinging-nettles[4]. When working at nests of these ants for several days the skin has peeled off my hands, and when I have worn gloves as a protection they have been burnt by the discharges of formic acid[64].

To determine the quantity of anhydrous acid contained in the liquid ejected by *F. rufa*, Poulton[63] invented an apparatus, which consisted of a glass tube containing filter-paper fastened to a glass rod fixed in the tightly fitting india-rubber cork. I obtained a number of these tubes and collected discharges from the ants; the percentage of anhydrous acid was found to fluctuate greatly in the various samples, strong samples containing from 60 to 70 per cent.

Mr. A. Vincent Briscoe of the Imperial College of Science, London, has kindly worked out for me the weight in grams of Formic Acid present per ant in a number of workers of *Formica rufa* which I obtained from Camberley; he obtained the following results:—

1. Ten ants were shaken in a stoppered bottle, which was rinsed out with water after the ants had been removed. The amount of acid found in the bottle was less than ·002 gm.

2. Ten ants were dropped into boiling water to extract the acid from them—these 10 ants gave ·021 gm. (=·0021 gm. per ant).

3. Fifteen ants (six dead and nine alive) were treated with boiling water—these 15 ants gave ·027 gm. (=·0018 gm. per ant).

He therefore concludes that each ant, on an average, contains about ·002 gm. (2 milligrams) of formic acid.

F. rufa is an omnivorous feeder, devouring insects, carrion, honey of flowers, honey-dew, the excreta of *Aphidae*, caterpillars, etc. etc.

The workers drag home to their nests both living and dead insects, exploring every tree and bush in the neighbourhood, and are thus of great value in clearing woods and forests of insect pests. It is

probable, considering how many insects, etc., the ants of a large colony may be seen to bring home per minute on favourable days, that they would bring in nearly one hundred thousand daily. Förster in 1850 states that the *rufa* nests near Aachen were nearly destroyed by the numbers of pupae taken from them to feed singing-birds[22], but according to Wheeler, " a German law passed in 1880, punishes with a fine of a hundred marks, or a month's imprisonment, any person who collects the cocoons of the fallow ant, *Formica rufa*, or wantonly disturbs its nests in the forest preserves "[80].

They also bring home seeds ; Weiss has shown that the large Wood Ant collects and helps to disperse the seeds of gorse and broom[75], and these seeds are provided with caruncles containing a large amount of oil, and resembling therefore the elaiosomes of other myrmecochorous plants.

On July 21st, 1908, I made a small collection of seeds from a nest of *F. rufa* at Chattenden, the seeds being obtained by taking them from the ants as they arrived at their nest. These seeds proved to belong to *Viola* sp. ?, *Carduus* sp. ?, *Arrhenatherum avenaceum*, false oat-grass, *Holcus lanatus*, soft-grass, and with them was a flower of the scarlet pimpernel[69]. The two first of these, the violet and thistle, are true myrmecochorous seeds, possessing food bodies, and were no doubt brought home for food, but the others are not, and were probably only picked up to add to the vegetable refuse on the nest.

Saunders records honey-bees being destroyed by *Formica rufa ;* in 1896, he writes—" A friend of mine living at Long Cross, near Chertsey, has had two hives of bees entirely destroyed by these little creatures, and a third was only saved by the gardener opening the hive and taking the ants out with his hands "[56]. The ants no doubt raided the hives for the honey, and bee larvae, and would also carry off the bees themselves as prey.

F. rufa may frequently be seen milking Aphides on trees and shrubs, etc. ; Lees in 1837 recorded seeing them attending plant-lice on thistles and brambles[10], and Warner in 1871 on oak twigs[22], but they are not supposed to harbour these insects in their nests. F. Smith wrote :—" I have not detected Aphides in the nests of this species "[31], and Wasmann states that *F. rufa* does not keep any *Aphidae* or *Coccidae* in its nests[88]. I have, however, several times found species of both *Aphidae* and *Coccidae* in *rufa* nests.

Pseudogynes are sometimes abundant in colonies of this species ; in September, 1908, I first found these curious forms in a nest of *F. rufa* at Nethy Bridge, a large proportion of the inhabitants of the nest consisting of them[69], and subsequently other colonies in the same district were found to possess them, and in both 1911 and 1912 nearly all the *rufa* nests examined at Nethy Bridge contained pseudogynes. On May 18th, 1912, one large nest, in the shape of

a perfect cone thirty-seven inches high and sixty-four inches in diameter, was found to contain, besides vast quantities of ordinary workers, many packets of eggs, larvae of all sizes in abundance, large numbers of worker and large cocoons, very many winged females, a very large number of deälated females, a few males, and pseudogynes in very considerable numbers.

Such a populous colony, apparently in a most prosperous condition, with plenty of both deälated females and ordinary workers, appears to entirely controvert the theory that pseudogynes have been brought about by the workers endeavouring to change female larvae into workers—or vice versa—to replace the scarcity of the latter caused by the presence of a beetle of the genus *Atemeles*. It may be added that pseudogynes occur in nearly every nest over the whole large area inhabited by *F. rufa* at Nethy Bridge, and that the most diligent search has never been rewarded by the discovery of an *Atemeles*, or its larva, there.

Lomnicki records that in Poland pseudogynes of *F. rufa* are rather rare[103].

Of all the indigenous ants, as pointed out by Latreille in 1802, the winged forms of this species appear first ; he says the winged females are to be found towards the middle of spring, either on the nests or at some distance from them, or even in the interior of towns, running on the walls and often without wings[4].

The winged sexes occur from April to August. Schenck records a winged female two hundred paces from a nest at Wiesbaden on April 26th[26] ; the earliest date given by Forel for isolated winged females in Switzerland is May 10th[38] ; Collett recorded that in 1883 the males began to appear at Guestling on May 21st and the females a week later[46] ; and Bignell found winged females on a nest at Shaugh Bridge on April 22nd, 1897[57].

On April 17th, 1912, I found *rufa* males out on fir posts, some distance from any nest, at Wellington College[89]; but on March 21st, 1920, when at Oxshott, I found a winged *rufa* female out at some distance from her nest, which is the earliest date of which I am aware for either of the winged sexes of this species. Plant states that swarming takes place from the end of July to the beginning of September[17], but he does not say that he has actually seen a marriage-flight, nor am I aware of any record of the actual mating of the sexes, other than the one to be mentioned shortly. Forel says he has seen the males and winged females of *rufa* ready to fly in the Engadine on July 10th, 1871[38], but he writes of the genus *Formica*—" One never sees the swarms formed by the ♀ and the ♂ of this genus ; at least I do not know of any description, and I have never seen it. The coupling certainly does not take place in the air, but may probably be on the tops of trees or hills." Standen records seeing a number of specimens of *F. rufa* flying at Grange on August 15th, 1909, at four o'clock in the afternoon, the

day being dead calm and very hot ; a great many gulls were seen to be catching the ants in the air[76].

On June 15th, 1911, I actually witnessed the coupling of the sexes at Aviemore in the middle of the afternoon. A number of *rufa* males and females were seen flying about in a timber yard, running about on a large mound of sawdust in the hot sunshine, flying off and settling on it, the males appearing to rise more easily than the females. Copulation took place on the mound ; I never saw a single pair together in the air. Sometimes a female would rise and fly straight up into the air, whilst others ran about on the mound, and occasionally when a male had found a female, the latter would refuse to have anything to do with him. I picked up one pair in copulation, when the female turned round and bit the male, and they separated. I found this female afterwards refused any other male that approached her[84].

On May 9th, 1922, a single winged female was seen running in a sand-pit in the New Forest, a marriage-flight having no doubt taken place that morning, the day being hot and sunny. When in Dean Forest in June, 1923, winged females were observed walking about the roads in the forest on the 13th and 16th, and a few deälated females on the latter date. A male was captured on the wing on the 14th ; evidently marriage-flights had recently taken place.

These ants commence to stir about February, according to the weather, when on fine days the workers have a habit of massing in the sun on the top of the nest, large numbers all resting in a heap upon each other, and the queens start to lay about this time—in my observation-nests they have begun to lay in December—and in nature these first eggs produce males and females, at least in large, or older, nests. On March 29th, 1912, Crawley and I found a very large *rufa* nest at St. George's Hill, Weybridge, which measured six feet in diameter, and it contained vast quantities of large (male and female) larvae and cocoons[89], but in 1913 all *rufa* nests examined by me were very backward, only eggs and very small larvae occurring as late as May 4th[94].

The worker larvae are reared next, and worker cocoons will be found in the nests up to October. I have found eggs in nests as late as August, and worker cocoons present in a nest at Wellington College on September 28th, 1912, but no eggs, larvae, nor pupae occur in the winter.

The pupae are generally enclosed in cocoons—the so-called " ants' eggs " which are used as food for singing birds, pheasants, etc., and robins are very fond of them, as, when a nest is disturbed, one of these birds will often sit near by, and flying down on to the nest, pick up a cocoon and fly off again.

The callows are helped by the workers to emerge from the cocoons, but they are also capable of liberating themselves.

Naked pupae also occur ; many such pupae, which were evidently pseudogynes, were present in a nest at Nethy Bridge in June, 1911[84], and on September 5th, 1913, I obtained a number of naked worker pupae in a *rufa* nest at Weybridge.

The Green Woodpecker is an enemy of *F. rufa,* as it devours these ants in the winter, making a long funnel-shaped hole in the hillock and extracting a number of individuals. I have seen these holes in a large nest at Pyrford, and the late Sir Charles Dilke, on whose property this colony occurred, told me that he had often seen the woodpecker at work on this hillock.

Bignell stated that a woodpecker will consume a small colony of *rufa* in the winter[58], and Wasmann records the ravages caused by this bird in *rufa* and *pratensis* nests at Exaeten in Holland in December, 1894, and in 1898. On February 28th, 1899, he found near *rufa* nests fifty droppings of the Green Woodpecker, containing no less than ten thousand *rufa* workers[67].

The females of this species have lost the power of founding their colonies unaided ; as we have seen, their communities spread over a large area, and the success of the species is greatly helped by the habit of colony splitting and forming branch nests.

After the marriage-flight large numbers of females are received back into the parent or other nests in the vicinity ; some find nests of another race, or of their own species elsewhere, whilst a considerably smaller number, having flown to *rufa*-free ground, endeavour to enter a nest of *Formica fusca.*

Probably the fact that *rufa* queens are received back into nests of their own species over a large area, has caused them to lose the instinct of colony-founding alone.

The large size of *rufa* females in proportion to their workers may also be due to the same reason, and the occasions on which they actually need to found colonies with the aid of *fusca* are not sufficiently frequent to have caused them to become dwarfed in size, or to develop mimetic or myrmecophilous characters, as is the case with some of the American forms. Large numbers of queens often occur in *rufa* nests, and though an occasional nest may be found in which it is difficult to detect a queen, the general rule is for colonies of this species to possess a good many. Wasmann records that in March, 1884, he found sixty old queens in a *rufo-pratensis* nest at Exaeten[66], and he subsequently mentions that he has several times found more than sixty queens in *rufa* nests in Dutch Limburg[72]. In April, 1911, Crawley and I dug up a *rufa* nest at Porlock in which were considerably over one hundred queens, and as we only investigated part of the nest the number must have been much greater[90]. At Weybridge also, and elsewhere, I have frequently observed a very large number of queens in a single *rufa* nest, and this condition is evidently brought about by

the acceptance, and readmission, of females after the marriage-flight.

It is also certain that females of the allied races will be accepted into each other's nests in the same way; Wasmann often found in *rufa* or *pratensis* nests, and especially in that of the mixed form *rufo-pratensis*, both *rufa* and *pratensis* queens side by side. In April, 1904, at Luxemburg he observed seven queens in a *pratensis* nest, of which five were true *pratensis*, one a *rufa*, and one a *truncicolo-pratensis*[72], and King has sent me to name from Nethy Bridge females of *pratensis* and *rufo-pratensis* from the same nest, the workers of this colony being *rufo-pratensis*, but much nearer to *pratensis* than *rufa*.

We now come to the founding of colonies by *rufa* queens in *fusca* nests. In 1904 Wheeler suggested that when more attention had been devoted to the incipient colonies of the European *F. rufa* (and *F. exsecta*), these ants would be found to be temporary social parasites in the colonies of *F. fusca*[65]. This he was led to predict, first, because he had found some of the North American allies of *F. rufa* (*F. consocians, microgyna, dakotensis, exsectoides*, etc.) to be temporary parasites on *F. incerta* and *subsericea*; secondly, because Forel and Wasmann had recorded the occurrence of a few small, mixed colonies of *fusca* with allies of *rufa* (*F. pratensis, truncicola, exsecta*, and *pressilabris*); and thirdly, because, notwithstanding the abundance of *F. rufa* in many parts of Europe, no one had ever seen one of its females in the act of establishing a colony independently.

His prophecy has since been fully justified, both by discoveries in the field and also by numerous experiments with observation-nests in the laboratory.

In 1908 Wasmann records that in May, 1902, he discovered at Shötter-Marial an isolated *rufa* female under a stone over a *fusca* nest, but separated from it by a partition of earth[71]. This female was evidently awaiting her opportunity to enter the *fusca* nest.

On April 14th, 1906, Schmitz and Wasmann found at Luxemburg a small mixed colony of *rufa* and *fusca*, containing a *rufa* queen only; and in May of the same year they found another in a less advanced stage, containing a *rufa* female with eggs and about one hundred fairly large *fusca* workers[71].

On July 20th, 1909, Wheeler found below the Turtmann Glacier a large nest of *F. fusca* under a pile of flat stones, which contained several hundred *fusca* workers, pupae and larvae, and in the midst was a *rufa* queen; and later on the same day, further down the Turtmann Valley, he found a second much smaller colony, comprising only fifty to eighty *fusca* workers, larvae, and a *rufa* queen, and lying close together in the centre of the nest were four dead but perfectly fresh *rufa* queens, each with her body cut in

two. Evidently five *rufa* females had entered the nest, but only one had been successful in being adopted as the queen[74].

On August 11th, 1909, Wheeler discovered near Zermatt under a small flat stone a little colony comprising about a dozen *fusca* workers, two dozen very small *rufa* workers, a *rufa* queen, and about fifty larvae and pupae of the latter species[74].

On May 15th, 1910, when in Parkhurst Forest, Isle of Wight, in company with J. Taylor, I observed a *rufa* female actually making her way into a *fusca* nest. A marriage-flight had evidently recently taken place, as many *rufa* females were noticed at large, some being winged and others deälated, and one of the latter was observed near an entrance to a *fusca* nest. There were several entrances into the ground in a sandy corner, whence *fusca* workers kept coming in and going out, and the *rufa* female made overtures to these workers and endeavoured to enter their nest. She had several fights with some of them, rolling over and over together on the ground, but eventually beat them off, and driving the more persistent ones away, she finally entered one of the doors of the nest and was lost to view[82].

On August 21st, 1910, Taylor and I again visited Parkhurst Forest, and during the day we found in an enclosure of young fir trees a very small *rufa* nest, which consisted of a small mound only eight or nine inches in diameter and about three inches high, but built of *rufa* materials in the usual way. The nest, which was most carefully dug up, only reached a depth of about six inches into the earth, and contained about one hundred and fifty, mostly very small *rufa* workers, a *rufa* queen, some fifty *fusca* workers, and a number of cocoons, which hatched later and proved to be *rufa* workers, but no *fusca* female was present[82].

On June 10th, 1911, in the Black Wood at Rannoch, I found a dead deälated *rufa* female in a *fusca* nest under a stone, which had evidently entered the *fusca* nest and had been killed by the workers, and on June 14th in the same locality, high up on a mountain where no *rufa* nests occur, I observed a deälated *rufa* female walking round a stone over a *fusca* nest. She eventually got under the stone and entered the nest, which contained a small *fusca* colony, but owing to lack of time I was unable to investigate further[84].

In June, 1911, Rüschkamp found in a weak colony of *F. fusca* at Alt-Valkenburg, a deälated *rufa* queen; some *fusca* larvae and pupae were present, but no *fusca* queen occurred[87].

On June 5th, 1912, R. Brun, having discovered a fairly strong colony of *F. fusca* under a stone near Glarus, proceeded to dig it up, but having unfortunately crushed the one *fusca* queen present, he replaced the workers and went away. Eight days later he revisited the spot, and found that the *fusca* workers had accepted a *rufa* female in place of their own dead queen[91].

This list of natural mixed colonies and observations in nature leaves no doubt that *Formica rufa* is a temporary social parasite in *F. fusca* colonies, but numerous experiments have been carried out by Brun, Crawley, Donisthorpe, Kutter, Rüschkamp, Wasmann, Wheeler, and Viehmeyer, etc., with generally successful results. The females usually employ conciliatory methods to secure adoption, but where they meet with stubborn resistance they resort to force to secure their ends.

It is a remarkable fact that in no single instance, when a mixed *rufa*⪯*fusca* colony has been found in nature, has a *fusca* queen been present. It is evident that a *rufa* female either selects a queenless *fusca* nest, or, if a *fusca* queen is present, the latter is probably killed by the *rufa* queen.

F. rufa and *pratensis* females, if kept alone, either die without laying eggs, or pay no attention to them if laid, but leave them scattered about where they have fallen. I have made a number of experiments to test if it was possible for a *rufa* and *fusca* queen to join together to found a colony, but without success, as the *rufa* female has always died, after a longer or shorter period, without laying eggs, even in those cases where she has become quite friendly with the *fusca* female. The following experiments will serve to illustrate how a *rufa* female is accepted into a *fusca* colony.

On January 28th, 1910, I confined some forty workers of *F. fusca* v. *glebaria*, obtained at Whitsand Bay in July, 1909, in one chamber of a two-chambered "Fielde-Janet" nest, blocking the passage between the two chambers with cotton-wool, and in the empty chamber I placed a deälated *F. rufa* female from Nethy Bridge. After a few days, to allow the female to get rid of her "nest aura," as would be the case in nature, the barrier was removed, when several workers entered her compartment, and she repeatedly entered their compartment, and returned, at first avoiding the workers. On February 2nd she was attacked, but regained her own compartment which now contained five workers, and the barrier was replaced, shutting her in with these five workers for the night. February 3rd she was again attacked, and she killed one persistent worker after first attempting to conciliate it by tapping and stroking it with her antennae; the remaining workers appeared more friendly and one fed the female. Other workers were now allowed to enter, which the female stroked with her antennae, but on February 6th she was again attacked by one, which she killed. The other workers were then introduced gradually, only one attacking her and being killed, and by February 9th all the workers were quite friendly; later she was again fed by a worker and was clearly adopted[79]. On March 1st she laid eggs, which came to maturity on June 20th; the eggs and larvae had been attended to by the *glebaria* workers; the callow *rufa* workers,

however, were cripples. She laid again on November 20th, 1910[82], and again on July 27th, 1911, and by August 16th, 1911, over twenty pupae were present, five of which hatched on September 25th, when there were over thirty pupae, all of which hatched by November 1st, being perfect, though small, *rufa* workers. The *rufa* queen, having lived in the nest for nearly two years, died on October 5th, 1911, from what cause is unknown, but it was certainly not through attacks by the *glebaria* workers[84].

In an experiment made by Wasmann, in May, 1909, a *rufa* female, which had been accepted by a *fusca* colony which possessed a *fusca* queen, after a few days bit off the head of the latter[73], and the following experiment also shows how when there is a *fusca* female present she may be got rid of.

On April 2nd, 1910, I brought home from Darenth Wood a number of *fusca* workers and three queens, which I had dug up out of a small sandy bank, and introduced them into a four-chambered "Janet" nest. On April 17th I placed a *rufa* female, taken at Wellington College the day before, into the last compartment of the nest, the *fusca* colony being in the second compartment. The next morning, April 18th, the *rufa* female was in the first compartment with three *fusca* workers; she was not being attacked and must have passed through the compartment containing the *fusca* during the night. During the day she was attacked by three others workers who entered her compartment, but she was not at all aggressive, and tried to conciliate them by stroking them with her antennae. Finally a worker dragged her by the jaws into the second compartment, where she was accepted by the *fusca* colony, and always remained with them. On June 1st one of the *fusca* females was found bitten in two, and though this action was not actually witnessed, there is little doubt that it was the work of the *rufa* female, as she often rested with her head over one or the other of the three *fusca* females. Later there were eggs in the nest, but it was impossible to say whether the *rufa* female had laid any of them, and on June 20th she died, but not from violence. Up to November 26th the gaster of the dead *rufa* female was carried about by one of the *fusca* workers[82].

This experiment also shows that for a time, at any rate, *F. rufa* and *F. fusca* females may live amicably together.

I have also made a number of other experiments in which *rufa* females have been accepted into strange *rufa* and *rufo-pratensis* colonies, as well as *fusca* colonies, but the above will be sufficient to show the methods adopted by *rufa* queens under these circumstances.

The following myrmecophiles have been found with *Formica rufa* in Britain :—

Coleoptera : *Aleochara ruficornis* Gr., *Microglossa pulla* Gyll., *Oxypoda formiceticola* Märk., *O. recondita* Kr., *O. haemorrhoa* Sahl.,

Thiasophila angulata Er., *Dinarda märkeli* Kies., *Myrmedonia humeralis* Gr., *Drusilla canaliculata* F., *Notothecta flavipes* Gr., *N. confusa* Märk., *N. anceps* Er., *Atheta analis* Gr., *A. parallela* Man., *A. sodalis* Er., *Heterothops* sp. ? (*nigra* Kr. ?), *Quedius brevis* Er., *Staphylinus stercorarius* Ol., *S. latebricola* Gr., *Xantholinus atratus* Gr., *Leptacinus formicetorum* Märk., *Othius myrmecophilus* Kies., *Scydmaenus godarti* Latr., *S. exilis* Er., *Batrisodes venustus* Reich., *Trichopteryx montandoni* All., *Ptilium myrmecophilum* All., *Ptenidium myrmecophilum* Mots., *P. kraatzi* Mat., *Coccinella distincta* Fald., *Hetaerius ferrugineus* Ol., *Dendrophilus punctatus* Hbst., *D. pygmaeus* L., *Myrmetes piceus* Pk., *Monotoma conicicollis* Aub., *M. formicetorum* Th., *Cetonia aurata* L. (larvae and pupae), *C. floricola* Hbst. (larvae and pupae), and *Clythra quadripunctata* L. (larvae and pupae).

Formicidae : *Formicoxenus nitidulus* Nyl., *Stenamma westwoodi* West., and *Leptothorax acervorum* F.

Ichneumonidae : *Microcryptus micropterus* Gr., and *Pezomachus vulpinus* Gr.

Braconidae : *Elasmosoma berolinense* Ruthe, *Pachylomma buccata* Nees, and *Acoelius viator* Först.

Proctotrupidae : *Tropidopria fuliginosa* Wasm., *Conostigmus myrmecobia* K., *C. wasmanni* K., *C. testacipes* K., *C. formicarum* K., *Ceraphron myrmecophilus* K., *C. formicarum* K., *C. abdominalis* K., *Lagynodes pallidus* Boh., *Baeus seminulum* Hal., *Polynema albitarse* K., *Ashmedopria sociata* K., *Aphanogmus formicarius* K., and *Platygaster* sp. ?

Cynipidae : *Kleditoma formicaria* K., *K. myrmecophila* K., and *K. subintegra* K.

Lepidoptera : *Myrmecozela ochraceella* Tgstr.

Diptera : *Ceratopogon myrmecophilus* Egg., *Phyllomyza formicae* Schmitz, *Pseudacteon* (=*Phora*) *formicarum* Verrall, *Apiochaeta* (=*Phora*) *pulicaria* Fall., *Scatopse infumata* Hal., *S. transversalis* L., *Limosina fungicola* Hal., *Trineura* sp. ?, *Medeterus truncorum* Mg., and *Sciara* sps. ?

Heteroptera : *Alydus calcaratus* L., *Myrmecoris gracilis* Sahl., *Nabis lativentris* Boh., *Piezostethus formicetorum* Boh., *Pilophorus cinnamopterus* Kirsch., *P. perplexus* D. and S., and *Megacoelum beckeri* Fieb.

Aphidae : *Lachnus formicophilus* Buckt., *Schizoneura corni* F., and *Aphis plantaginis* Schr.

Coccidae : *Newsteadia floccosa* West., and *Orthezia cataphracta* Shaw.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic.

Myriapoda : *Polyxenus lagurus* L., *Julus pulchellus* Leach, and *Proteroiulus fuscus* Am. Stein.

Araneina : *Thyreosthenius biovata* Camb., *Tetrilus arietinus* Thor., *Cryphoeca recisa* Camb., *Microneta viaria* Bl., *M. innotabilis* Camb., and *Micarisoma festiva* C. K.

Pseudoscorpionina : *Chernes scorpioides* Herm.

Acarina: *Trachyuropoda coccinea* Mich., *Laelaps* (*Oolaelaps*) *oophilus* Wasm., *L.* (*O.*) *montanus* Berl., *L.* (*Cosmolaelaps*) *cuneifer* Mich., *Myrmonyssus acuminatus* Berl., *Urodinychus* sp. ?, and *U. Janeti* Berl.

Crustacea : *Platyarthrus hoffmanseggi* Brdt.

Formica rufa L., var. rufo-pratensis Forel.

Formica rufa rufo-pratensis Forel Denkschr. Schweiz Ges. Naturw. **26** 16–17[1] 53[2] 56[3] (1874). *Formica pratensis* var. *rufo-pratensis* Dalla Torre Cat. Hym. **7** 205 (1893)[4]. *Formica rufa rufa* var. *rufo-pratensis* Emery Deutsch. Ent. Zeitschr. **1909** 186[5]. *Formica rufa* var. *rufo-pratensis* Wasmann Arch. Trim. Inst. R. Grand-Ducal Luxemburg **4** 13 (1909)[6]. *Formica rufo-pratensis* Donisthorpe Ent. Rec. **21** 257 (1909)[7]. *Formica rufa* var. *rufo-pratensis* Donisthorpe Entom. **44** 390 (1911)[8] : Ent. Rec. **25** 65 (1913)[9]. *Formica rufa rufa* var. *rufo-pratensis* Wheeler Bull. Mus. Compar. Zoöl. **53** 427 (1913)[10]. *Formica rufa* var. *rufo-pratensis* Donisthorpe Ent. Rec. **26** 40 (1914)[11] : **29** 49 (1917)[12]. *Formica* (*Formica*) *rufa* var. *rufo-pratensis* Emery Gen. Ins. **183** 253 (1925)[13].

Original description [Forel Denkschr. Schweiz Ges. Naturw. **26** ☿ 53 ♀ 56 (1874)] :—

☿ " *F. rufo-pratensis* (*polyctena* Först. [?] *et piniphila* Schenk). Ces formes ont parfois un caractère un peu particulier, sont plus petites que les formes typiques, ont les couleurs moins nettes, etc. Elles se trouvent dans les clairières, au bord des bois et surtout dans les montagnes. Elles tiennent ordinairement plutôt de la *F. rufa* pour les poils et de la *F. pratensis* pour la couleur (*rufa* foncées et petites). Mais on en trouve aussi qui sont *pratensis* pour les poils et *rufa* pour la couleur. Il y a aussi des fourmilières intermédiares en tout point. Les différences dans la longueur respective des faces du metanotum (*F. polyctena* Först.) n'ont aucune constance ; elles varient énormément dans la même fourmilière."[2]

♀ " *F. rufo-pratensis*. Abdomen ni mat ni luisant partout, plutôt luisant."[3]

Forel's var. *rufo-pratensis* embraces all the intermediate forms between *F. rufa* L. and *F. pratensis* Retz. ; it is probable that the *polyctena* Förster and the *piniphila* Schenck, which are usually regarded as synonyms of *rufa*, both represent some one of these intermediate forms, but it is quite useless to try and fix a name to any particular form. Emery states :—" Old authors have distinguished several forms on account of the different condition of the erect hairs in the worker : the forms with hardly any bristles on the head and thorax embrace the *F. rufa* Först. and *polyctena* Först. ; distinctly bristled make *F. piniphila* Schenck. The latter represents the first degree of a variety of intermediate forms going over to *F. rufa pratensis* which represent var. *rufo-pratensis* Forel—☿, ♀, and ♂ declare themselves in all their characteristic distinctions (colour, hairiness, shining of the gaster in the ♀, etc., which distinctions appear to combine together in every possible way and stage) as bringing together *rufa rufa* and *rufa pratensis*."[5]

It is usual with transitional forms that all the individuals in one colony belong to the same form, and Forel gives a valuable table to illustrate the different zoological and embryological forms that may occur[1] :—

"

Légères variations du couleur, etc., dans la même fourmilière.		Fourmilière I F. rufa	Fourmilière II F. rufa pratensoides.	Fourmilière III F. rufo-pratensis.	Fourmilière IV F. pratensis rufoides.	Fourmilière V F. pratensis.
	♂					
	♀					
	Inter-médiares entre ☿ et ♀ (☿♀)					
	Grandes ☿					
	Moyen ☿					
	Petites ☿					

The top line represents five different colonies, starting with *rufa* and gradually passing into *pratensis*, and it is understood that all the individuals in each colony belong to the same race, or form of variety, whichever it may be.

The side line represents the different embryological forms which may occur in each colony. Forel's intermediate forms between the worker and female are what are now called pseudogynes.

It is not, however, always the case with *rufo-pratensis* that only one variety is found in the same colony ; Forel himself states that once or twice he has seen typical individuals and others distinctly passing to a neighbouring form in the same colony. He once sent two *rufo-pratensis* workers, taken in the same colony and mounted on the same pin, to an emerited myrmecologist, and the latter stood him out that the one was *F. rufa* and the other *F. pratensis*. Forel says :—" I hardly think that I have succeeded in convincing him of the fact."[1]

Wasmann says :—" It remains still to be settled whether the intermediates between the two races rest on direct variation, or rather on crossing between the pure races of *rufa* and *pratensis*. I am rather inclined to the latter opinion."[6]

I believe that in localities such as the Isle of Wight, where *rufo-pratensis* is found, but where *pratensis* does not, and has never been known to occur, the former rests on direct variation from *rufa* proper, and in these cases the variety is found to be much nearer to *rufa ;* whereas in the Highlands, where both *rufa* and *pratensis* are present, the varieties have chiefly sprung from crossing between *rufa* and *pratensis* males and females. We have already seen, under *rufa*, that colonies of *rufa*, *pratensis*, and *rufo-pratensis* will each receive the other's queens after the marriage-flight, and a combination of all these facts will alone explain the contents of some of the nests I have seen from Nethy Bridge.

In 1909 I recorded *rufo-pratensis* from Nethy Bridge, the colouring of the ants being darker than that of *rufa*, but they did not possess the hairiness of *pratensis*, and I mentioned that the nests differed somewhat from those of *rufa*, being more compact, the dome-shaped surface smoother and flatter, and the nest material not so loose—capable of being moved in layers. A point which struck me very much was the way in which many of the nests were being extinguished by the undergrowth. Moss starts to grow round the base of the nests, then " bilberry " and heather, which creep upwards all round the hillock, gradually driving the ants to the summit, and eventually extinguishing the colony. Most of the hillocks in the valley covered with dense undergrowth have once been ants' nests[7].

On September 8th, 1912, I found two nests of this variety at Parkhurst Forest, Isle of Wight, which were situated on a bank, constructed of finer materials than the *rufa* nests in the neighbourhood, and in fact looking more like *exsecta* nests. The workers were of a yellow-red colour, with a neat, well-marked black spot on the pronotum ; this is very distinct in some specimens, which also have another black spot on the mesonotum[9]. Several nests of *rufo-pratensis*, superficially like *exsecta* nests, were again found in Parkhurst Forest on June 29th, 1913, which were situated in clumps of grass (*Aira caespitosa*)[11]. A deälated female was taken, but only worker cocoons were present, and in August another deälated female, and a male, were found in the same locality. The male appears to have the wings a little blacker than in *rufa*, probably only an individual variety, and the females have the gaster duller and more punctured than in *rufa* proper.

I have seen specimens of *rufo-pratensis* taken by Butler at Bexhill, by Best Gardner at Briton Ferry in Glamorgan, by W. Gardner at Deganwy and Crafnant, Conway Vale, by Hallett at Castell Coch near Cardiff, by Rothney at Bournemouth, by H. Scott at Kingsteignton, South Devon, and Wheeler tells me he took it at Low Wood, on Lake Windermere, when he was in England in 1912.

The following myrmecophiles have been taken with *F. rufa* v. *rufo-pratensis* in Britain :—

Coleoptera : *Oxypoda haemorrhoa* Sahl., *Thiasophila angulata* Er., *Notothecta flavipes* Gr., *N. anceps* Er., *Atheta parallela,* Man., *Quedius brevis* Er., *Leptacinus formicetorum* Märk., *Dendrophilus pygmaeus* L., *Monotoma conicicollis* Aub., and *Clythra quadripunctata* L. (larvae).

Braconidae : *Pachylomma buccata* Nees (large specimens).

Diptera : *Phyllomyza formicae* Collin.

Araneina : *Thyreosthenius biovata* Camb.

Acarina : *Laelaps* (*Oolaelaps*) *oophilus* Wasm.

Formica rufa L. var. alpina Sants.

Formica rufa var. *alpina* Santschi Bull. Soc. Ent. France **1911** 349[1] ; Forel Rev. Suisse Zool. **19** 458 (1911)[2] ; Donisthorpe Entom. **44** 390 (1911)[3] : Ent. Rec. **24** 8 (1912)[4] ; Emery Deutschr. Ent. Zeitschr. **1912** 672[5]. *Formica rufa rufa* var. *santschii* Wheeler Bull. Mus. Compar. Zoöl. **53** 428 (1913)[6]. *Formica rufa* var. *alpina* Donisthorpe Ent. Rec. **26** 40 (1914)[7] : **29** 49 (1917)[8] : **31** 24 (1919)[9]. *Formica* (*Formica*) *rufa* var. *santschii* Emery Gen. Ins. **183** 253 (1925)[10].

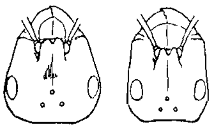


Fig. 89. 1. Head of *Formica rufa* ☿.
2. Head of *F. rufa* v. *alpina* ☿.

☿ *Size and colour much as in* rufa, *but with closer and slightly more abundant pubescence, and distinctly more hairy in the Rannoch specimens.*

Head long, narrow, with straight cheeks ; *frontal area* duller and more punctured than in *rufa ;* *eyes* with sparse hairs ; *scapes* of *antennae* long and projecting further beyond the posterior corners of the head than in *rufa*. *Thorax* a little narrower with the *pro-* and *mesonotum* more convex. *Scale* with golden bristles, more abundant in the Rannoch specimens. *Legs* more hairy than in *rufa,* particularly so in the Scotch specimens. *Long.* 5·5–8·5 mm.

♀ *Size and colour much as in* rufa ; *but more pubescent and hairy.*

Head long, narrow, with straight cheeks ; *frontal area* duller and more punctured than in *rufa ;* *eyes* with sparse hairs ; *scapes* of *antennae* projecting further beyond the posterior corners of the head than in *rufa* (this is brought about by the shape of the head, as the scapes, when measured, are not longer, and sometimes not so long, as in *rufa*). *Thorax* a little narrower, with *mesonotum* more convex anteriorly ; *meso-* and *metathoracic sternites* and *epinotum* with some long *golden* hairs. *Scale* and anterior margin of *gaster* furnished with long golden hairs ; *gaster* duller, more closely punctured than in *rufa,* with the red colour on the anterior portion of the first segment well marked. *Legs* more hairy than in *rufa.* *Long.* 9·5–10·5 mm.

I have not seen a male, nor a winged female ; the worker is described from Continental and numerous Scotch specimens, the female from eight deälated specimens from Rannoch. The

Scotch specimens only differ from the Continental ones in being more hairy.

Original description of *Formica rufa* var. *alpina* Santschi (Bull. Soc. Ent. France 1911 349) :—

" Taille, couleur et pilosité comme chez le type. La tête est beaucoup plus allongée et plus étroite en avant (un quart plus longue que large chez *alpina* et à peine un cinquième chez le type). Le scape dépasse davantage le bord occipital. Le thorax est plus étroit avec un promésonotum plus convexe. L'abdomen est légèrement plus large. Le reste semblable.

Montagne au Nord de Sondrio (Valteline). Reçue de M. le Pr. Galli Valerio."

Santschi says :—" To this form ants of other provinces connect themselves by the same character (the elongate head) but of variable colours. This is the case with examples from Munich sent to me by Professor Emery, which have the colour and pilosity of *F. truncicola.* This made me suspicious that this curious morphological modification might possibly be due to parasitism. Wheeler, Emery, Wasmann, Janet, etc., have already pointed out a dimorphism more or less constant with other ants infested either with entoparasites such as *Mermis* and *Pelodera*, which inhabit the abdomen or the pharyngeal glands of the adult, or by ectoparasites living as commensals at the expense of the larvae[1]."

On June 11th, 1911, I found at Rannoch, on the edge of a moor, a small mound made of heather, etc., which was superficially very like a nest of *F. exsecta*; the workers running about on the mound, according to the habit of that species, were mostly small in size and very red in colour, and might have easily been taken for it, nor were there any tracks to and from the nest such as are found with *F. rufa.* On examining the workers they were at once seen not to belong to *exsecta*, and the nest being dug up four deälated females were found to be present. Having come to the conclusion that it was a form new to Britain I sent specimens to Forel, and he wrote :—" Your ants belong to a group of varieties which I once called *truncicolo-pratensis*, they are nearly the colour of the var. *dusmeti* Emery from Norway and Spain, and recently Santschi has discovered and distinguished it in our Alps under the name of *F. rufa* var. *alpina* in litt. I myself have received it from Norway and the Black Forest, etc., and have also found it in Switzerland. It is distinguished above all by the more narrow head, as Santschi has shown. It has some erect hairs on the tibiae (hairs which fail in true *F. rufa*) and some sparse hairs on the eyes "[4].

In July, 1913, when again at Rannoch, this time in company with Morice, we visited the same spot where I originally discovered *alpina* and some seven colonies were observed ; deälated females were found, three in one nest, and two in others, and pseudogynes were present in one nest, but no winged ants were seen[7]. The nests

PLATE XIV.

Nest of *Formica rufa* v. *alpina*. Rannoch, 16.VII.13.
(The white disc is a half-crown to show the size of the nest.)

Nest of *Formica pratensis*. Rannoch, 17.VII.13.
(The white disc is a half-crown to show the size of the nest.)

Face page 398

were all small hillocks, chiefly composed of heather, and were distributed over a small area of the moor and its borders. Workers and larvae of a form of *Myrmica scabrinodis* (before mentioned under that species) and *Leptothorax acervorum* were found in two of the nests, and the beetle *Notothecta flavipes* also occurred. In August, 1918, Metcalfe and Whittle found the little moth *Myrmecozela ochraceella* in some abundance in a nest of this variety at Rannoch[9].

Joy sent me some ants which he took, in July, 1913, at Loch Shin in Sutherland, and Rothney from Lochan-Eilean, Inverness-shire, and St. Filans,[9] Perthshire, and among them I detected a number of workers of the var. *alpina*.

As all the ants, both females and workers, in the colonies I have found possess the narrow-shaped heads, it does not seem probable that this is due to parasitism, as suggested by Santschi.

Formica pratensis Retz.

[" Fourmi rousse des prés " De Geer Mém. Hist. Ins. **2** 1080–81, 1173 Pf. 42·12–15 (1771)[1].] *Formica pratensis* Retzius Gen. Spec. Ins. De Geer 75 (1783)[2]. *Formica rufa* Christ Naturg. Ins. 510–511 Pf. 60·7–8 (1791)[3]. [" La fourmi fauve dos noir " Huber Mœurs Fourmis (1810)[4].] *Formica congerens* Nylander Acta. Soc. Sc. Fenn. **2** 906 (1846)[5]: **3** 27[6] 30[7] (1849); Förster Hym. Stud. **1** 17–20 (1850)[8]; Schenck Jahrb. Ver. Naturk. Nassau **8** 11[9] 30–33[10] 138[11] (1852); Mayr Verh. Zool. Bot. Ver. Wien **5** 332–333 (1855)[12]; F. Smith Cat. Brit. Foss. Hym. 6 (1858)[13]: Trans. Ent. Soc. Lond. (n.s.) **4** 278 (1858)[14]: Ent. Ann. **1858** 39[15]: Ent. Mo. Mag. **2** 29 (1865)[16]: Ent. Ann. **1865** 85[17] 87[18]: **1866** 126–127[19]; Buchanan-White Scot. Nat. **1** 222 (1872)[20]; H. Müller Berfrucht. Blumen **464** (1873)[21]. *Formica rufa* r. *pratensis* Forel Denkschr. Schweiz Ges. Naturw. **26** 52[22] 219[23] 365–368[24] 373[25] 408[26] (1874). *Formica pratensis* Forel Bull. Soc. Vaud. Sc. Nat. **14** 58 61 (1875)[27]. *Formica congerens* Saunders Trans. Ent. Soc. Lond. **1880** 205[28]; Parfitt Trans. Devon. Assn. Sc.-Art **12** 513 (1880)[29]. *Formica pratensis* Er. André Spec. Hym. Europe **2** 184 (1881)[30]. *Formica congerens* Bignell Young Nat. **3** 143 (1882)[31]. *Formica pratensis* Forel Ann. Soc. Ent. Belg. **30** 136 138–139 (1886)[32]; Wasmann Tijdschr. Ent. **34** 46–47 (1891)[33]; Dalla Torre Cat. Hym. **7** 204 (1893)[34]. *Formica congerens* Farren-White Ants' Ways 202–203[35] 231–232[36] (1895). *Formica rufa* race *pratensis* Saunders Hym. Acul. 21 (1896)[37]. *Formica pratensis* Forel Zool. Jahrb. Suppl. **7** 580 (1904)[38]; Wasmann Biol. Centralb. **25** 199–200 (1905)[39]: Zeitschr. Wissens. Insektenbiol. **2** 42 (1906)[40]; Wheeler Journ. Psychol-Neurol. **13** 426–427 (1908)[41]; Wasmann Arch. Trim. Inst. R. Grand-Ducal Luxemburg **4** 13–18 (1909)[42]. *Formica rufa pratensis* Emery Deutsch. Ent. Zeitschr. **1909** 186–187[43]. *Formica pratensis* Wheeler Ants 222[44] 445[45] (1910). *Formica rufa* subsp. *pratensis* Donisthorpe Entom. **44** 390 (1911)[46]: Ent. Rec. **24** 9 (1912)[47] *Formica rufa pratensis* Wheeler Bull. Mus. Compar. Zoöl. **53** 428–429 (1913)[48] *Formica pratensis* Donisthorpe Ent. Rec. **26** 40–41 (1914)[49]. *Formica* (*Formica*) *rufa pratensis* Emery Bull. Soc. Ent. Italiana **47** 256 (1916)[50]. *Formica pratensis* Donisthorpe Ent. Rec. **31** 2 (1919)[51]; Lomnicki Bull. Ent. Pologne **3** 26 (1924)[52]; Brun Schweiz Arch. Neur-Psychial. **16** 86–99 (1925)[53]. *Formica* (*Formica*) *rufa* subsp. *pratensis* Emery Gen. Ins. **183** 254 (1925)[54]. *Formica pratensis* Donisthorpe Ent. Rec. **38** 19 (1926)[55].

☿ *Colour much as in* rufa, *but usually darker, with the black spot on the pronotum reaching the posterior border and often fusing with the black spot on*

the mesonotum; the anterior border of the scale is often black, and the gaster is all black; legs darker than in rufa, *being chiefly brown, and the whole body considerably more hairy. In small specimens the greater part of the body is usually blackish.*

Head: shape as in *rufa;* frontal area duller and more punctured than in *rufa; eyes* with short outstanding hairs. *Thorax* as in *rufa,* but with *pronotum* covered with outstanding hairs. *Scale* as in *rufa,* but furnished with abundant outstanding hairs; *gaster* with closer pubescence and with more abundant outstanding hairs than in *rufa. Legs* with decumbent pubescence closer than in *rufa* and furnished with suberect hairs as well as the usual bristles. *Long.* 4·5–9·5 mm.

♀ *Very like* rufa, *but more hairy and pubescent, and with the gaster distinctly pubescent.*

Head: shape as in *rufa,* with *frontal area* more punctured; *eyes* sparsely hairy. *Scale* hairy; *gaster* closely punctured, pubescent, and furnished with outstanding hairs, especially on the anterior border. *Legs* with closer and longer decumbent pubescence than in *rufa,* and with suberect hairs as well as the usual bristles. *Wings* as in *rufa. Long.* 9·5–11 mm.

♂ *Very like* rufa, *but slightly more robust, and distinctly more hairy.*

Head: shape as in *rufa,* but with more abundant outstanding hairs; *eyes* more hairy. *Thorax* considerably more hairy; *mesonotum* with pit-like punctures less distinct than in *rufa,* being more obscured by the hairs. *Scale* more hairy; *gaster* with more abundant erect hairs, and closer and more plentiful decumbent pubescence. *Legs* with suberect hairs besides the usual bristles, and with closer and more abundant decumbent pubescence than in *rufa. Wings* as in *rufa. Long.* 9·5–11·5 mm.

In Continental and Bournemouth specimens the workers appear to run larger, and the colours are more distinct, the red being brighter, and the black more neatly defined.

Original description of *Formica pratensis* Retz :—

" Fourmi rousse des prés. 2. Fourmi rousse à tête et à ventre noirs, à écaille sur le filet du ventre " [De Geer Mém. Hist. Ins. 2 1080 (1771)].

" 325. *F. pratensis,* rufa, capite abdomineque nigris, petiolo abdominis squamifero T. 2 p. 1080 " [Retzius Gen. Spec. Ins. De Geer 75 (1783)].

Habitat.

Formica pratensis ranges over Northern and Central Europe, Siberia, and is found on the Island of Sakhalin; in Europe it extends southward to Southern Italy in the high mountains[48].

British distribution—It is probable that some of the older British records of *F. pratensis* only refer to *F. rufa,* and possibly the var. *rufo-pratensis*—Farren-White credits Dale with the capture of *pratensis* at Holnest, Porlock, and Exmouth[36], but there are no specimens labelled with these localities in the Dale Collection, and I have examined the inhabitants of great numbers of wood-ants' nests at Porlock, all of which were pure *rufa.*

Parfitt says he met with two small nests of *congerens* in Stoke Wood near Exeter in September, 1879[29], but I have seen no specimens in any collection from Devonshire, and neither Bignell

Plate XV.

Male, female and worker of *Formica pratensis*.

Face page 310

nor Keys ever found it in that county; moreover, I have had specimens of *rufa* sent to me from near Exeter with the remark that these ants are the commonest species in the woods in that neighbourhood.

F. pratensis certainly used to occur more commonly near Bournemouth, as there are many specimens in the Dale and F. Smith collections from that locality, but it had not been found there for many years, until I found a single colony in June, 1914. I have examined hundreds of wood-ants' nests in that neighbourhood, all of which, with the exception of the one just mentioned, have proved to belong to *F. rufa*.

F. Smith writes (of *pratensis*) in 1866—" This is the common wood-ant at Bournemouth; I have not yet found *F. rufa* there "[19] —but he had already recorded taking *F. rufa* (as well as *F. pratensis*) at Bournemouth in August, 1864[17]!

Farren-White also states—" The former (*F. congerens*) is the common wood-ant of Bournemouth . . . the common wood-ant (*F. rufa*) is very rare at Bournemouth "[35].

Bignell in 1882 refers to Farren-White's remarks and says—" Since the above was written, the writer had occasion to pass through Bournemouth, and having four hours to spare visited a pine-wood about a mile from the town, saw only one ant-hill, and brought away twenty-one workers from it, which are certainly *F. rufa* "[31].

It would seem that the latter had nearly replaced *F. pratensis* in this locality; but in September, 1925, however, I found several nests of *F. pratensis*, situated near to the spot where I found a colony in 1914.

It is best to regard the British distribution of *F. pratensis* as follows, until further records are forthcoming :—

Dorset : Morden near Bloxworth (*Haines*); Bloxworth Heath (*O. P.-Cambridge*)[51].

Hants, S. : Bournemouth (*F. Smith*)[16].

Northumberland, S. : Corbridge (*Donisthorpe*)[47].

Cumberland : Lodore, Derwent Water (*Wheeler*).

Mid Perth : Rannoch (*Foxcroft*)[14].

Easterness : Nethy Bridge (*F. X. King*).

F. pratensis is very like *F. rufa* in many ways and has similar habits, but, as Schenck pointed out in 1852, it is not quite so fierce, and does not spray its acid so easily[10], and Forel says it has more need of sun, and can put up with a greater degree of drought[23].

On the Continent it prefers to nest in meadows, fields, and along the borders of woods and hedges, indeed De Geer stated *pratensis* only occurs in fields and not in woods[1], and André also gives fields, borders of hedges, etc., though he says it is rarely found in clearings in woods[30]. Wasmann points out that in Holland *pratensis* occurs

more commonly in woods and copses than it does in Luxemburg, where it forms nests in more open places[42].

According to Lomnicki it is not nearly as common as *F. rufa* in Poland[52].

Mayr says this ant sometimes lives entirely underground, no hillock being constructed over the nest[12], and Farren-White found it acting as a miner in a turf bank at Bournemouth[35], and he says its nests though often seen in the pine-woods in that locality, are as often found on the open heath[36]. He discovered a large nest on a sloping bank of fern and heather and gorse, on the margin of a running stream, the depth at the crown of the nest measuring twelve inches, and eighteen inches down the slope of the bank seven inches across the nest ; from the upper part to the base on the declivity seventy-two inches ; and a foot from the crown, fifty-three inches across ; the circumference measuring eighteen feet and four inches[35].

The colony I found at Bournemouth on June 15th, 1914, was situated in the grass by the side of a road. Their hillock, which was nine or ten inches high and fifteen to eighteen inches in diameter, was built at the foot of a small gorse bush, but not among trees, and was composed of coarse materials—long twigs, bits of straw, etc.—and the ants had collected a number of wooden matches, and small pebbles from the footpath near the road, which they had mixed with the other materials of the nest. These ants were mostly large in size and brightly coloured as in Continental specimens.

This nest remained in the same spot until 1917 when the border by the side of the road was dug up and planted with shrubs, etc., and many houses built in the neighbourhood. This, however, would be more likely to drive away *rufa ;* and, as we have seen, I discovered in 1925 several colonies quite close to the original spot—one being situated in a deserted *exsecta* nest[55].

According to Forel, *pratensis* will live a little nearer to human habitations than *rufa*, and is sometimes found in gardens in villages in Switzerland[23]—when I was staying with him at Yvorne in 1912, he showed me a nest in a field quite close to his house.

The nests are similar to those of *rufa*, but smaller on the average, being not so high, flatter, and composed of coarser materials, and sometimes occur in old tree-stumps which are covered by the hillocks.

Nylander records nests in Finland made of bits of grass, birch twigs, etc.[6], and Wasmann says that in Dutch Limburg they are generally covered with a layer of rabbits' excreta, this being very characteristic of *pratensis* in that region[33], and, on the other hand, in Luxemburg where rabbits are scarce, this ant uses the droppings of hares in a similar way[42]. On June 28th, 1900, in the neighbourhood of Luxemburg he found a nest of *pratensis* which appeared to

be covered with rabbits' droppings, but on closer observation he found that the layer consisted of the dry seed-heads of *Centaurea pratensis*[40].

The colonies of this ant are usually smaller than those of *rufa*, and they may occur singly, or near to each other, Schenck says three or four nests will often be found close together[10], and Wheeler mentions that *pratensis* often makes " tenuous paths " which are roofed over along much of their extent with vegetable detritus and connect the different nests of a colony with one another[44].

In June, 1911, I discovered two *pratensis* nests situated close to each other among the fir trees near the Lock at Rannoch[47], the one a small, rather flat hillock, the other considerably larger built over a pine stump, both being constructed of pine-needles, bits of heather, etc. On June 10th the smaller nest was dug up, and some workers were taken, but no queen was found, and on June 12th the inhabitants were found to have deserted the remains of their nest and to have amalgamated with those of the larger colony. It was found impossible to get at the bottom of the large nest, even with the help of a spade and axe on account of the deeply rooted pine stump, and again no queens were found.

In July, 1913, a number of colonies were found in this same spot[49]—which consisted of rough, hilly ground, some parts of it swampy, with higher dry places and paths winding round the stumps of cut-down trees among the heather, with a number of large Scots Firs scattered about—the workers travelling long distances on the paths to some of the nests. The bottoms of these nests consisted of chambers and galleries constructed in the peaty ground beneath the hillocks, and in these galleries deälated females were found.

Forel observed a colony of *F. pratensis* migrating to a new nest, with a third nest serving as a magazine midway. He says the workers carry their fellows, and also the females, and males, by the mandibles, in the same manner as that employed by *F. rufa*, and the migrating of *pratensis* is distinguished from that of *sanguinea* and *fusca*, by their greater numbers together (*plus grand ensemble*)[24]. It was during this migration that he made his calculation as to the numbers of the inhabitants of a nest (referred to under *rufa*), and he also observed the curious behaviour of a large worker, which was evidently unwell,* stumbling on the old nest, with

* Brun[53] records the case of a *pratensis* worker suffering from some malady which caused it to walk round and round, in larger and smaller spirals ; always towards the right. When its companions endeavoured to carry it into a quiet corner, it attacked and bit them, and behaved as if it were quite mad. It continued this walking in circles with longer and shorter pauses from June 26th to July 1st [1924], when it was killed by being placed in alcohol. After Brun had dissected it, under the microscope, he found it had a tumour on the brain—this he very ably figures and describes.

the tarsi and antennae drooping, with one mandible open and the other shut. He saw other workers approach her, lick and tap her with their antennae, and endeavour to lead her gently, pulling her by the legs, into the interior of the nest. One more persistent worker tried hard to rouse her, and the suffering ant at last appeared to understand a little more what was wanted, tucking up her legs and antennae, and allowing herself to fall, but without grasping the mandible of the other worker. The latter at last seized hold of two of her legs and carried her towards the new nest. This couple was found a quarter of an hour later several paces along the route towards the new nest, the carrier persisting in conveying the sick ant forward in that direction. Forel says here is a case where an ant which was unwell was made the subject of special attentions by her companions; Ebrard and Huber cite some more touching but, perhaps, less certain cases. As Forel points out, this is not the usual practice, and ants which are unwell are more often deserted, or thrown out of the nest, which has generally been my own experience. Forel has observed workers of *pratensis* playing together, performing gymnastics, etc., such as we have already seen to be performed by those of *rufa*.

The food of *pratensis* is similar to that of *rufa*, and Müller records finding workers of the former on flowers of *Rosaceae* and *Compositae*[21].

There is no fixed time for the appearance of the winged forms, nor for the marriage-flight of *F. pratensis*, indeed Forel states with regard to the swarming, that this is the most irregular of all ants in that respect. He has found the males and winged females in the nests in Switzerland in May, June, July, August, and September, the earliest date being May 2nd[26].

Förster records the winged sexes at Aachen at the beginning of May, appearing most commonly in the early morning[8].

Schenck found males in a colony at Weilburg on May 16th, 1882, this sex not having occurred until June 1st, in the same nest the year before[11]. He says they come up on to the top of the nest at from seven to nine or ten o'clock in the morning, but do not appear later in the day[10], and he has noticed that as soon as they show signs of leaving the nest, the workers take them back by force, even dragging them from the grass stems near by, into the nest[9]. He observed a double swarm, in June, and from the end of September to the beginning of October, in the same nest, in the same year[9].

Wheeler writes—" At Vaud I had the pleasure of seeing the huge *pratensis* nest which Forel has had under observation for the past forty years. The colony inhabiting this nest has had a succession of queens during this period, showing that the colonies of these temporary parasites, when once established, may perpetuate themselves by adopting females of their own species and thus attain an extraordinary age. Just as Professor Forel and I approached the

nest at about 10 a.m. on June 5th, the males and winged females were leaving it for their nuptial flight "[41].

On June 3rd, 1906, I took a winged female *pratensis* at Corbridge, in Northumberland, near a *rufa* nest, and on June 11th and 12th, 1911, I captured a very few males in, and also away from, the nest, at Rannoch, but on July 17th, 1913, when I was in company with Morice, males and winged females were found to be abundant in one nest in that locality[49], only sex pupae occurring in another.

Beck found males present in my Bournemouth nest on June 14th, 1915.

The colony founding of *pratensis* is similar to that of *rufa*, branch and twin nests occur, and females are received back into the nests after the marriage-flight ; and the latter also found their colonies in nests of *F. fusca* and its races. Wheeler says that in Southern Europe *pratensis* probably prefers the var. *glebaria* of *fusca* as a host[48].

In small *pratensis* colonies usually only one queen occurs, but in larger and older ones more are generally to be found—Wasmann says six to eight queens are not at all rare in Luxemburg[39], and I found four queens in one nest at Rannoch, in which nest pseudogynes were also present.

In 1906 at Shötter Marial Wasmann three times found young *pratensis* colonies which contained only a few hundred workers, no *fusca* being present[42], which no doubt originated in a split from an older colony with a young queen.

On August 30th, 1871, Forel found near the summit of Mont Tendre a small mixed colony of *pratensis* and *fusca* which contained worker *pratensis* cocoons[25] ; on September 8th, 1887, Wasmann discovered near Exaeten, at the foot of an old oak stump, another small mixed colony of the same two species[39] ; and Wheeler records that in Switzerland during the summer of 1907 he found on two or three occasions a recently killed, but not mutilated, *pratensis* queen in the recesses of a *fusca* nest[45].

All these discoveries in nature demonstrate the founding of colonies in *fusca* nests, by *pratensis* females.

The following myrmecophiles have been found with *F. pratensis* in Britain :—

Coleoptera : *Oxypoda formiceticola* Märk., *O. haemorrhoa* Sahl., *Leptacinus formicetorum* Märk., *Trichopteryx montandoni* All., *Ptenidium myrmecophilum* Mots., *Monotoma conicicollis* Aub., and *Cetonia floricola* Hbst. (larvae).

Formicidae : *Formicoxenus nitidulus* Nyl., and *Leptothorax acervorum* F.

Collembola : *Cyphodeirus albinos* Nic.

Araneina : *Thyreosthenius biovata* Camb.

Acarina : *Laelaps* (*Oolaelaps*) *oophilus* Wasm.

Formica exsecta Nyl.

Formica exsecta Nylander Acta Soc. Sc. Fenn. **2** 909–911 (1846)[1]: **3** 27 (1849)[2]; Förster Hym. Stud. **1** 23 (1850)[3]; Schenck Jahrb. Ver. Naturk. Nassau **8** 38 (1852)[4]; Mayr Verh. Zool. Bot. Ver. Wien **5** 340 (1855)[5]; F. Smith Ent. Ann. **1865** 85 87–88. Pf. [1]·2[6]: **1866** 126[7]: **1869** 69–72[8]. *Formica exsecta* r. *exsecta* Forel Denkschr. Schweiz Ges. Naturw. **26** 51[9] 140[10] 220[11] 368[12] 371[13] 409[14] (1874). *Formica exsecta* Saunders Trans. Ent. Soc. Lond. **1880** 206[15]; Er. André Spec. Hym. Europe **2** 178 (1881)[16]; Dalla Torre Cat. Hym. **7** 195 (1893)[17]; Farren-White Ants' Ways 57[18] 203–205[19] 232[20]. Tf·36 (1895); Saunders Hym.-Acul. **21** (1896)[21]; Bradley Ent. Mo. Mag. **33** 46 (1897)[22]: **35** 14 (1899)[23]; Vic. Hist. Worcester **1** 87 (1901)[24]; Hamm Ent. Mo. Mag. **38** 266 (1902)[25]; Holmgren Zool. Jahrb. **20** 353–370 (1904)[26]; Donisthorpe Ent. Rec. **17** 182 (1905)[27]; Escherich Ameise 222 (1906)[28]; Butler Ent. Mo. Mag. **43** 254 (1907)[29]; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 223 (1908)[30]; Wasmann Biol. Centralb. **28** 298–306 (1908)[31]: Arch. Trim. Inst. R. Grand Ducal Luxemburg **4** 39–44 (1909)[32]. *Formica exsecta exsecta* Emery Deutsch. Ent. Zeitschr. **1909** 190[33]. *Formica exsecta* Donisthorpe Ent. Rec. **21** 257–258 (1909)[34]: **22** 83 (1910)[35]: Entom. **44** 390 (1911)[36]: Trans. Ent. Soc. Lond. **1911** 179–180[37]: Ent. Rec. **23** 10–11 (1911)[38]: **24** 10 (1912)[39]; Emery Deutsch. Ent. Zeitschr. **1912** 672[40]; Donisthorpe Ent. Rec. **25** 65 (1913)[41]; Beare Ent. Rec. **25** 258 (1913)[42]; Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 42–43 (1913)[43] *Formica exsecta exsecta* Wheeler Bull. Mus. Compar. Zoöl. **53** 489 (1913)[44]. *Formica exsecta* Wheeler Psyche **21** 26 (1914)[45]. *Formica* (*Formica*) *exsecta exsecta* Emery Bull. Soc. Ent. Italiana **47** 256 (1916)[46]. *Formica exsecta* Donisthorpe Ent. Rec. **30** 24 (1918)[47]: **34** 3 (1922)[48]. *Formica* (*Adformica*)* *exsecta* Lomnicki Bull. Ent. Pologne **3** 25 (1924)[49]. *Formica* (*Formica*) *exsecta* Emery Gen. Ins. **183** 257 (1925)[50].

☿ *Yellowish red; head posteriorly, a more or less distinct patch on the pronotum, and sometimes a smaller one on the mesonotum, and the apex of the antennae brown; gaster brownish black, with base of first segment more or less reddish; legs yellowish red, tibiae and tarsi darker.*

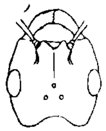


Fig. 90. Head of *Formica exsecta* ☿.

Head narrower than long, narrowed anteriorly and posteriorly, the breadth at the anterior and posterior borders being equal, deeply excised posteriorly; *clypeus* carinate, not emarginate anteriorly; *frontal area* smooth and shining; *mandibles* with terminal border furnished with eight teeth, which are much blunter in some specimens than in others; *maxillary palpi* long, six-jointed.

* In 1924 Lomnicki[49] founded the subgenus "*Adformica*" for the species of *Formica* in which the head is excised posteriorly in the worker, female and male; and the workers vary little in size. He mentions that two species occur in Poland—*F. exsecta* Nyl., and *F. pressilabris* Nyl., but he does not cite either as type. I propose *Formica exsecta* Nyl., as the type of this new subgenus; by present designation.

Thorax not very convex; constriction between *mesonotum* and *epinotum* shallow, broad; *epinotum* rounded. *Scale* not large, deeply excised. *Long.* 4·5–7·2 mm.

♀ *Yellowish red; head posteriorly, apex of antennae, thorax (except pronotum anteriorly, and epinotum) and gaster blackish brown; legs yellowish, or brownish, red.*

Characters much as in ☿. *Head* deeply excised posteriorly; *clypeus* not emarginate anteriorly. *Thorax: mesonotum* flat. *Scale* larger and more deeply excised than in the ☿. *Wings* yellowish, with pale brownish yellow veins and pterostigma. *Long.* 8–9·5 mm.

♂ *Black, genitalia and legs yellowish brown, articulations of the joints lighter.*

Head dull, distinctly and widely excised posteriorly; *clypeus* not emarginate posteriorly; *mandibles* not toothed on terminal border; *maxillary palpi* as in ☿ and ♀; *eyes* large, with sparse hairs. *Thorax* dull. *Scale* short, thick, with anterior border excised; *gaster* shining. *Wings* not as yellow as in the ♀, with pale brownish yellow veins and *pterostigma. Long.* 6·5–8 mm. (6–9 mm. *teste Wheeler.*)

Original description of *Formica exsecta* Nylander [Acta. Soc. Sc. Fenn. 2 909-11 (1846)]:—

" *Operaria:* ferrugineo-rufa parum nitida, abdomine castaneo-atro; palpis, antennarum flagellis et vertice fuscescentibus; occipite late emarginato; squama cordata, supra profunde exsecta; pedibus sparse pilosis.

☿ Long. 2–2½ lin. Parum nitida, colorata ut supra dictum; minora tamen individua verticem castaneo-fuscam, antennas fere totas et pedum saltem tibias fuscescentes habent. A *F. rufa,* cui leviter inspecta similis videtur, differt jam: mandibulis magis complanatis, occipite concavo, clypeo margine inferiori magis truncato, supra vestigio carinulae medianae, squama cordata h.e. ovata sursum parum latiori, supra semiovaliter excisa, colore abdominis atriori, pubescentia denique corporis conspicuiori (canitie sericeo-micante vix ulla). Palpi labiales articulo ultimo oblongo, longitudine 3: tii. Metanotum a latere visum arcuatum. Pedes pilis sparsis obsiti; tibiis latere interiori versus apicem sparse setulosis. Segmentum anale rufescens.

Femina: testaceo-rufa flavido-pubescens nitida; palpis, antennis, fronte cum vertice, thorace supra et abdomine castaneo-atris; clypei disco, mesosterno et mesopleuris fuscescentibus; occipite late emarginato; squama cordata vel supra profunde exsecta; alis hyalinis obsoletissime fuscedine tinctis, nervis cinero-flavidis, stigmate parum fusciori.

♀ Long. 3¼ lin. Sat longe flavido-pubescens valde nitida, capite fere ut in ☿. Clypeus obsolete convexiusculus, margine infero tenui in medio rectâ late truncato; vestigio vix ullo carinulae. Linea frontalis elevatiuscula. Oculi parce pilosuli, pilis his nonnullis parvis tenuibus apice flexis. Thorax mesonoto toto cum parte adjacente prothoracis, scutello, postscutello, mesopleuris et mesosterno obscurius vel dilutius infuscatis. Alae ut in diagnosi, stigmate pallide fusco; anticae 3½ lin. longae. Pedes pubescentes, tibiis cum tarsis saepe cinerascentibus vel obscurioribus. Squama ut in ☿ valde compressa, profunde semiovaliter exsecta. Abdomen nitidum crebre subtiliter flavido pubescens, pubescentia ventris longiori. Basis abdominis truncata maculà magnâ et segmentum anale rufa.

Mas: niger parum nitidus brevius pubescens, genitalibus et pedibus vel totis vel ad partem testaceo-pallescentibus; occipite parum emarginato; squama transversim subrectangulari crassa, supra late concaviuscula; alis hyalinis stigmate fusco.

♂ Long. 3–3¼ lin. Similis mari *F. rufae,* sed magis nitidus, occipite concaviusculo alarumque colore nullo statim distinguitur. Brevius flavido

pubescens quam ♀, abdominis pubescentia subtiliori decumbente. Oculi, ut in ♀, tenuissime pilosuli; ocelli in cacumine verticis elevatiusculi. Alae hyalinae ne minimis fere vestigiis fuscescentiae, nervis flavido-cinereis, stigmate fusco; anticae fere 3¼ lin. longae. Pedes vel pallescenti-cinerei, coxis obscurioribus vel femoribus fere totis cum tibiis tarsisque pallide testaceis, pubescentiâ flavidâ cinerascentibus. Genitalia fere ut in *F. rufa*. Marginibus segmentorum certo situ magis nitidis, concoloribus."

Habitat.

Formica exsecta ranges over North and Central Europe; Alps, Caucasus, Siberia, Altai Mountains[44]. Wheeler has recently described a new variety from Japan under the name of *fukaii*[45]. In North America *F. exsecta* is represented by the well-known mound-building ant of the Alleghanies, *Formica exsectoides* Forel, which builds very large nests and establishes huge colonies—one of these studied by McCook comprising some one thousand six hundred nests!

Its British distribution is as follows:—

Cornwall, W.: Land's End (*Isabell*).

Devon, S.: Bovey Tracey (*Hamm*)[25].

Dorset: Lyme Regis (*Nevinson*); Poole (*F. Smith*)[7].

Isle of Wight: Parkhurst Forest (*E. A. Butler*)[29].

Hants, S.: Bournemouth (*F. Smith*)[6]; Boscombe[19] and Ringwood[18] (*Farren-White*); Parkstone (*Saunders*)[21]; New Forest (*Bradley*)[23].

Worcester: Bewdley (*Blatch*)[24].

Mid Perth: Rannoch (*Donisthorpe*)[39].

Aberdeen, S.: Braemar (*Donisthorpe*)[38].

Easterness: Aviemore[34] and Nethy Bridge (*Donisthorpe*)[41]; Boat of Garten (*Beare*)[42].

Formica exsecta nests in sunny places, on the borders of woods, in clearings of woods and forests, in unsheltered places, on open heaths, by the sides of paths and roads, in clumps of grass, and rarely under stones. It does not like the neighbourhood of human habitations, and is fast disappearing from the heaths round Bournemouth, being driven away by building operations. The nests of *exsecta* are smaller, and are built of much finer materials than are those of *rufa*, being chiefly composed of grass and ling, but fern fronds, and bits of other plants, and sometimes a few pine-needles and other vegetable refuse are used—a typical *exsecta* nest can be recognized at a glance.

In 1907 Butler swept a single *exsecta* worker in Parkhurst Forest, Isle of Wight[29], and, having told me whereabouts he thought he had taken it, on April 26th, 1909, I visited the locality in company with Taylor, and this spot having been drawn blank, we went further into the forest, when I found a small deserted nest, which I at once recognized as that of *exsecta*, and a little further on we came upon a very suitable situation for this species, being a clearing

PLATE XVI.

Nest of *Formica pratensis*. Bournemouth, 15.VI.14. (Hamm.)

Nest of *Formica exsecta*. Rannoch, 16.VII.13.

Face page 318.

planted with young fir trees, when we immediately found four inhabited *exsecta* nests. A large nest near, which from its construction and materials had evidently belonged to *exsecta*, was found to be inhabited by *F. rufa*, either the former having deserted, the latter had occupied this old nest, or else the latter had forcibly taken possession[34].

These nests are dome-shaped, or sometimes somewhat conical, their size about that of a football, seldom more than eight or ten inches in height, and often smaller. Galleries are excavated in the earth beneath the hillock, and when the latter is built over gorse or tough grass-roots, etc., the nest is very difficult to dig up thoroughly, in consequence of which deälated females are not often obtained. Two or more nests will often be found close together—I have found two nests so situated by the side of a road over the moor at Aviemore, two large nests side by side near a path at Braemar, a number of nests near each other at Bournemouth, and in Parkhurst Forest four or five nests may be found in one clearing, several at intervals along a ride, and others scattered all over the forest—I have counted over twenty nests in one day there.

Isolated nests often occur, and when a nest has grown to a large size, some of the workers will migrate with a young queen to a new situation near by.

Forel mentions an immense colony of *F. exsecta* he found in a clearing at the foot of Mont Tendre[11], consisting of more than two hundred nests occupying a radius of over one hundred and fifty metres ; all the nests being connected with each other by paths, and all the ants in the different nests on friendly terms with one another.

On the other hand, in Wasmann's experience, isolated nests are more usual with this ant, he neither saw in Vorarlberg and Tirol, nor in Rhineland and Westphalia nests connected with each other. He found that single nests belonged to single colonies, and that at Linz am Rhein where *exsecta* was common, the inhabitants of nests only three metres away from each other were enemies[31].

I have, however, found these ants from the same locality to be friendly with each other, even after being separated for a long interval.

On April 26th, 1909, I took a small colony of *exsecta* in Parkhurst Forest, consisting of a deälated female and a number of workers, and established them at home in a combined " Fielde and Janet " nest, and on May 15th, 1910, I obtained about one hundred workers, some eggs and larvae (the queen was not found) from a colony near the same spot, and introduced them into my nest, which I wanted to strengthen, as many workers had died, only the queen and seven workers remaining. The new and old workers were quite friendly together, much excitement prevailed, and a

great deal of tapping of antennae took place all round. The eggs and larvae were collected into a heap in one corner of the nest and the queen rested upon them ; no fighting took place, no dead ants were present next day, and the nest was kept under observation for some years[38].

F. Smith endeavoured in June, 1868, to establish a colony of *exsecta* in his garden at Islington, and he writes :—" On the morning of my leaving Bournemouth, I rose early, and, taking a spade and a tin box, I set out for the purpose of obtaining a nest of *Formica exsecta*. At the early hour of five o'clock, I found a nest with its inmates apparently in quiet repose, not an ant was to be seen. . . ."

He dug up the nest without disturbing it and brought it bodily to London, where he established it in his garden at Islington.

" On the following morning I visited my ants' nest, when, what was my astonishment, on beholding a line of black ants extending from the nest to the root of a lilac tree in the corner of the garden ; one troop of ants were on their way from the tree to the nest, whilst another was travelling in the opposite direction ; each ant laden either with a larva or pupa of *Formica exsecta* ".

At first he suggested that he had discovered *Formica* (i.e. *Acanthomyops*) *niger* in the character of a slave-making ant—a quite impossible solution—but subsequently he realized the true state of affairs and he goes on—

" I was, however, doomed to be again disappointed ; in a few days every larva, pupa, and worker was conveyed into the nest of *Formica niger*, and from that time the most careful watching failed to discover any trace of *Formica exsecta ;* I have not any doubt of the whole contents of the nest having become the food of the colony of the black ants "[8].

Forel, however, was more successful in Switzerland ; on June 12th, 1871, he brought a large quantity of ants taken from the colony of *exsecta* at Mont Tendre, before mentioned, to Vaux, and placed them on the border of a small wood. The ants at once commenced to build a nest, and to attack two colonies of *Acanthomyops niger* and one of *A. flavus* which were situated in the neighbourhood, the siege lasting for two or three days, and numbers of the *niger* and *flavus* were killed and chased away. The *exsecta* workers in troops invaded the shrubs in the neighbourhood, and drove away workers of *A. niger* and *F. fusca*, taking possession of the plant-lice belonging to these ants. They also attacked some *Camponotus ligniperdus* workers on a tree at some distance from the nest, but were eventually repulsed with heavy loss. After some days two nests were established on the borders of the wood, one being built over the nest of one of the vanquished *niger* colonies. The *exsecta* workers never went out alone, at least for the first eight days, but always in bands, so that when one of their number was attacked, twenty other workers would come to the rescue, but they

never went near the *Camponotus* nest again. This *exsecta* colony flourished and was still under observation in 1874[12].

Holmgren has observed that the nests of *F. exsecta* in the bogs of Lapland are destroyed by the growth of a moss (*Polytrichum strictum*) which gradually invades the mounds of these ants, and covers them with a dense carpet. The moss is then replaced by a growth of sphagnum, and many other plants eventually take root in it, so that the ants are instrumental in the forming of these hillocks of moss, and hence helping the growth of peat-forming vegetation[26].

F. exsecta is a very active and fierce ant, and when its nests are disturbed the workers rush out, swarm all over the invader, and bite most viciously.

They are somewhat abrupt in their movements; they possess good sight, but very little individual initiative. When the workers attack other species, they advance together in troops in fairly close formation and always try to avoid the grasp of an enemy—a number seizing the latter by its legs and antennae and pulling in different directions as hard as they can, whilst one of their number springs on to the back of the captive and endeavours to cut off its head.

Large nests are very populous, and a colony may consist of over one thousand, or, as Wasmann suggests, perhaps ten thousand, individuals[32].

According to Escherich the marriage-flight takes place in June and July without swarming[28]; André says the winged sexes appear in June and July[16], Rothney found males and winged females at Bournemouth on July 14th, 1868[8], and I have taken them in abundance in nests in the same locality at the end of August and the beginning of September, 1905; sex pupae taken in June in Parkhurst Forest and in July at Rannoch, 1913, hatched in the latter month.

Forel captured an incomplete lateral ergatandromorph in a wild colony in Switzerland, which he briefly described:—

Worker with some portions of the left side male. Stature of ordinary worker. Male portions: a longitudinal black band under the head, left half of pronotum a large V-shaped black blotch on mesonotum, a black protuberance (scutellum ?) and vestiges of alar articulations. All the rest worker. Epinotum malformed[10].

Forel states the eggs are late in appearing and gives May 6th as the first date[14], but, in captivity at any rate, the females lay earlier than that—Wasmann records that a female in a colony in his possession laid eggs in February, larvae being present in March[31], and eggs were laid in my observation-nest in the latter month. Worker cocoons are present in the nests up to late in the year. As we have seen, new *exsecta* nests are established and a colony

spreads by means of branching, etc., some young queens are retained in the nests, and others would be accepted back after the marriage-flight into the different nests of a large colony.

Young females of *F. exsecta,* however, also found their colonies in nests of *F. fusca,* and as the *exsecta* female is smaller in comparison with her workers than is *rufa*—being smaller than large *fusca* females—and dark in colour, she is more readily accepted into the *fusca* nests ; mimicry playing some part in the matter.

The reason why no very early stage of a mixed colony (a female *exsecta,* and *fusca* workers only) has been observed in nature is probably that an *exsecta* queen would easily be overlooked among the *fusca* workers, but later stages of mixed colonies have been found—in September, 1867, Forel discovered in a wood near Apples a very small mixed colony of *F. exsecta* var. *rubens* and *F. fusca*[13] ; on April 26th, 1870, Bugnion found a mixed colony of *exsecta* and *fusca* near Lausanne, and in the following year at Ormonts another of *exsecta-pressilabris* and *fusca* under a stone[13]. In October, 1906, Wasmann dug up at Luxemburg an *exsecta*≏*fusca* colony in a simple earth nest of the *fusca* type, containing an *exsecta* queen, several hundred *exsecta* and *fusca* workers, and pupae of the former, but no *fusca* female was present[31].

On May 27th, 1910, I found an isolated nest on the borders of a wood at Bournemouth, of the usual *exsecta* type but very small, and on being examined it proved to contain both *exsecta* and *fusca* workers, the latter being in considerably greater numbers. It was impossible to properly dig up the nest, on account of the presence of gorse roots, etc., in the ground, and no female was found, but here undoubtedly was a new *exsecta* colony, founded by a young queen of that ant, which had entered a *fusca* nest, and been accepted by the inhabitants[37]. On August 26th, 1911, Hamm also found a mixed colony of *exsecta* and *fusca* at Bovey Tracey, in Devonshire[43]. In 1916 Perkins found a very strong mixed colony of *exsecta*≏*fusca* also in Devonshire ; and on July 15th, 1921, Harwood found several mixed nests of these two species at Rannoch.

Some of the *F. exsecta* nests found by me in Parkhurst Forest, which were situated in the ground with very little nest materials built over them, were suggestive of a recent *fusca* origin, as was also an isolated nest, found by the side of a road at Aviemore, which was partly situated under a large stone, a heap of nest materials being built up on one side, whilst under the stone were galleries such as are constructed by *F. fusca*[35].

The following myrmecophiles have been taken with *F. exsecta* in Britain :—

Coleoptera : *Oxypoda haemorrhoa* Sahl., *Dinarda hagensi* Wasm., *Myrmedonia limbata* Pk., *Drusilla canaliculata* F., *Notothecta*

flavipes Gr., *N. anceps* Er., *Atheta analis* Gr., *Othius myrmecophilus* Kies., and *Dendrophilus punctatus* Hbst.

Formicidae : *Leptothorax acervorum* F.

Proctotrupidae : *Ceraphron flaviventris* v. *subterranea* K.

Lepidoptera : *Amphisbatis incongruella* Staint.

Diptera : *Ceratopogon myrmecophilus* Egg., and *Apiochaeta* (=*Phora*) *rata* Wood.

Heteroptera : *Ceratocombus coleopetratus* Zett.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic.

Myriapoda : *Blanjulus guttulatus* Gerv.

Araneina : *Micaria pulicaria* Sund.

Acarina : *Laelaps* (*Cosmolaelaps*) *cuneifer* Mich.

Crustacea : *Platyarthrus hoffmanseggi* Brdt.

F. sanguinea Latr.

Formica sanguinea Latreille Ess. Hist. Fourmis France 37 (1798)[1] : Hist. Nat. Fourmis 150 (1802)[2]. [" La fourmi sanguine " Huber Mœurs Fourmis 275–288 (1810)][3]. *Formica sanguinea* F. Smith Zool. **1** 262–264 (1843)[4]. *Formica dominula* Nylander Acta. Soc. Sc. Fenn. **2** 905 1047 (1846)[5] : **3** 26 (1849)[6]. *Formica sanguinea* Förster Hym. Stud. **1** 20 (1850)[7] ; Tischbein Stett. Ent. Zeitg. **12** 295–297 (1851)[8] ; Schenck Jahrb. Ver. Naturk. Nassau **8** 11[9] 14[10] 36–38[11] 139[12] 145[13] (1852) ; Mayr Verh. Zool. Bot. Ver. Wien **5** 336–338 (1855)[14] ; F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 101–103 (1855)[15] : Cat. Brit. Foss. Hym. 6–7 (1858)[16] : Ent. Mo. Mag. **2** 29 (1865)[17] : Ent. Ann. **1868** 93–94[18] : **1871** 58[19] ; Forel Denkschr. Schweiz Ges. Naturw. **26** 52[20] 219[21] 261[22] 324–330[23] 358–364[24] 408[25] (1874) : Bull. Soc. Vaud. Sc. Nat. **14** 57–58 (1875)[26] ; Saunders Trans. Ent. Soc. Lond. **1880** 205–206[27] ; Er. André Spec. Hym. Europe **2** 180 (1881)[28] ; Lubbock Ants, Bees, and Wasps 41–42[29] 441[30] (1882) ; Rothney Ent. Mo. Mag. **18** 262 (1882)[31] ; Forel Ann. Soc. Ent. Belg. **30** 139–140 (1886)[32] ; Lubbock Journ. Linn. Soc. Lond. **20** 118 (1888)[33] ; Darwin Origin Species **I** 338–342 (1888)[34] ; Wasmann Tijdschr. Entom. **34** 46 (1891)[35] : zusam. Nest. gemischt. Kolon. Ameisen 46–52 (1891)[36] ; Rothney Ent. Mo. Mag. **28** 50 (1892)[37] : **29** 67 (1893)[38] ; Dalla Torre Cat. Hym. **7** 211 (1893)[39] ; Farren-White Ants' Ways 167–179[40] 183[41] 232–233[42] (1895) ; Saunders Hym.-Acul. 21 (1896)[43] ; D. Sharp Camb. NH. Ins. **2** 149–150 (1899)[44] ; Vic. Hist. Hants **1** 115 (1900)[45] : Worcester **1** 87 (1901)[46] ; Morice Ent. Mo. Mag. **37** 96 (1901)[47] ; Barnes Ent. Mo. Mag. **38** 265 (1902)[48] ; Wasmann Verh. Deutsch. Zool. Gesell. **12** 100 (1902)[49] : Insektenbörse **20** 275–276 (1903)[50] : Biol. Centralb. **25** 200–210 (1905)[51] ; Wheeler Bull. Amer. Mus. NH. **21** 1–16 (1905)[52] ; Vic. Hist. Sussex **1** 131 (1905)[53] : Berks **1** 76 (1906)[54] ; Escherich Ameise 48[55] 134[56] 222[57] (1906) ; Donisthorpe Ent. Record **19** 254 (1907)[58] : **20** 281 (1908)[59] : Trans. Leicester Lit.-Phil. Soc. **12** 222 (1908)[60] ; Wasmann Biol. Centralb. **28** 369–376 (1908)[61] : Arch. Tri. Inst. Grand Ducal Luxemb. **4** 44–75 (1909)[62] ; Donisthorpe Ent. Rec. **21** 257 (1909)[63] : Zool. **1909** 463–466 : Tf. 1 2[64] ; Forel Arch. Sc. Phy.-Nat. **28** Sept. 6–8 (1909)[65] ; Viehmeyer Zeits. Wissens. Insektenbiol. **5** 353–356 390–394 (1909)[66] ; Emery Deutsch. Ent. Zeitschr. **1909** 182–184[67] ; Wasmann Biol. Centralb. **30** 481 (1910)[68] ; Wheeler Ants 454–458 (1910)[69] ; Donisthorpe Ent. Rec. **22** 83 (1910)[70] : Trans. Ent. Soc. Lond. **1910** 142–150[71] : **1911** 178–179[72] : Entom. **44** 390 (1911)[73] ; Forel Int. Ent. Cong. Bruxelles **2** 1910 101–104 (1911)[74] ; Donisthorpe Ent. Rec. **24** 9–10 (1912)[75] : **25** 65 (1913)[76] : Rep. Lancs-Chesh. Ent. Soc. **36** 1912 41–42 (1913)[77] ; Crawley and Donisthorpe Int. Ent. Cong. Oxford **2** 1912 55–63 (1913)[78]. *Formica sanguinea sanguinea* Wheeler Bull. Mus. Comp. Zoöl. **53** 401–403 (1913)[79] *Formica sanguinea* Rüschkamp Biol.

Centralb. **33** 668–675 (1913)[80]. *Rdptiformica** (*Formica*) *sanguinea* Forel Ann. Soc. Ent. Belg. **57** 361 (1913)[81]. *Formica sanguinea* Donisthorpe Ent. Rec. **26** 41 (1914)[82]; Crawley Ent. Rec. **26** 141 (1914)[83]; Pinkney Ent. Rec. **26** 142 (1914)[84]; Schmitz Jaar. Natuur. Genoots Limburg **1915** 99[85]; Donisthorpe Ent. Rec. **28** 3 (1916)[86]. *Formica* (*Raptiformica*) *sanguinea* Emery Bull. Soc. Ent. Italiana **47** 257 (1916)[87]. *Formica sanguinea* Donisthorpe Ent. Rec. **29** 49 (1917)[88]: **30** 21 (1918)[89]: **31** 24 (1919)[90]; Lomnicki Bull. Soc. Polonaise Nat. Leopold **1921** 98[91]; Donisthorpe Ent. Rec. **34** 1 3 82 (1922)[92]: **36** 52 (1924)[93]. *Formica* (*Raptiformica*) *sanguinea* Emery Gen. Ins. **183** 259 (1925)[94].

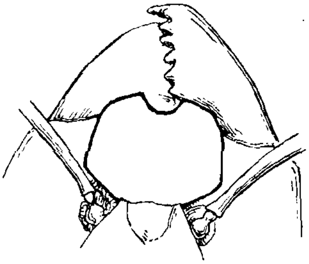


Fig. 91. Anterior portion of head of *Formica sanguinea* ☿ to show emargination of clypeus.

☿ *Head, thorax, petiole, antennae, and legs, lighter or darker red, gaster greyish black. Front and vertex of head darker, sometimes blackish; gaster sometimes reddish at base of first segment; hairs, and pubescence except on gaster, sparse.*

Head broad, slightly, but widely emarginate posteriorly; *clypeus* emarginate in centre of anterior border, not distinctly carinate except in some specimens; *frontal area* finely shagreened; *mandibles* broad, furnished with strong teeth on terminal border. *Thorax* robust, the constriction between mesonotum and epinotum deep and angular; *epinotum* highest posteriorly, forming a rounded angle, descending in a rather flat straight surface to base. *Scale* broad, usually slightly emarginate at apex; *gaster* covered with thick grey pubescence. *Long.* 5–9 mm.

♀ *Usually darker than the* ☿, *pubescence and hairiness as in the* ☿; *young winged females are generally lighter in colour than old queens.*

Head more blackish than in the ☿, the red colouring more brown; *clypeus* emarginate in centre of anterior border. *Thorax* large; *mesonotum* flat above, with slight blackish patches at anterior border and insertion of the wings. *Wings* brownish with basal halves darker, veins and pterostigma pale yellowish brown. *Long.* 9·5–10·5 mm. (9–11 mm. *teste Wheeler.*)

♂ *Black, apex of antennae, legs and genitalia reddish yellow. Head* dull, broad, with posterior border not emarginate; *clypeus* emarginate in centre

* As pointed out by Wheeler [Bull. Amer. Mus. **45** 699 (1922)]: The two subgenera *Raptiformica* Forel and *Serviformica* Forel are regarded as utterly untenable. *Raptiformica* is based on the presence of a notch in the anterior margin of the clypeus; but this is present in several North American species (*F. munda*, *F. manni*, etc.) which do not make slaves like the Holartic *sanguinea*. Moreover, some of the forms allied to *F. subpolita*, which should belong to *Serviformica* Forel, have a slight but distinct notch in the outer border of the clypeus.

of anterior border ; *mandibles* with four or five teeth on the terminal border. *Thorax* dull. *Scale* thick, widely but not deeply emarginate at apex ; *gaster* somewhat shining, finely pubescent. *Wings* as in ♀, but with veins and pterostigma darker. *Long.* 6–10 mm.

Original description of *Formica sanguinea* Latreille [Ess. Hist. Fourmis France 37-38 (1798)] :—

" 11. * F. sanguine. *sanguinea.* O. g. D'un rouge sanguin. Yeux et abdomen noirs. Trois petits yeux lisses. Ecaille ovée, un peu échancrée."

Habitat.

Formica sanguinea is distributed throughout the Palæarctic region, but in the southern portions of Europe and Asia it only occurs in hilly or mountainous country. In Europe it ranges south as far as Sicily, in Asia as far as the Himalayas (Cashmir) and Lahoul, on the frontier of Thibet[79].

Four varieties have been described—from Siberia, the Caucasus, Andalusia, and Japan—and it is represented in North America by some five subspecies, and varieties.

The British distribution is as follows :—

Dorset : Parley Heath (*Haines*).

Hants, S. : New Forest (*F. Smith*)[16] ; **Hants, N. :** Cove[4], Hawley[16], and Blackwater (*F. Smith*)[19] ; Selborne (*Dale Coll.*) ; Fleet (*E. A. Butler*).

Sussex, E. : Hove (*Unwin*)[53] ; Guestling Wood (*Donisthorpe*).

Kent, W. : Westerham and Brasted (*Harwood*).

Surrey : Weybridge[15] and Croydon (*F. Smith*)[17] ; Chobham[27] and Woking (*Saunders*)[43] ; Byfleet (*Morice*) ; Blackheath, near Guildford (*Champion*) ; Shirley (*Rothney*)[31] ; Ewhurst and Leith Hill (*E. A. Butler*) ; Hindhead (*Donisthorpe*).

Essex, S. : Thundersley (*Whitaker*).

Berks : Wellington College and Crowthorne (*Farren-White*)[42] ; Burghfield (*Barnes*)[54] ; Mortimer (*Hamm*).

Bedford : Heath-on-Reach, near Leighton Buzzard (*G. Crawshay*).

Worcester : Wyre Forest[46] and Bewdley (*Martineau*).

Salop : Marsh Wenlock (*Whitaker*).

Westmorland : Grange-over-Sands (*Whitaker*).

Mid Perth : Rannoch (*Donisthorpe*)[77].

Easterness : Aviemore and Nethy Bridge (*Donisthorpe*)[58].

Formica sanguinea, the blood-red Robber Ant, our only slave-maker, is one of the most interesting species, showing great intelligence in adapting its habits to varying circumstances. It is a restless, warlike, and courageous ant, running rapidly, and attacks an intruder fiercely when its nest is disturbed, biting viciously and ejecting acid, but not raising the gaster between the

legs, as do *rufa* and *pratensis*, when angry. This species lives in clearings of woods, on heaths and commons, on the borders of woods and hedges, by the sides of roads and paths, and loves heathy land near pine woods.

It prefers uncultivated places, sometimes dwelling in meadows, at a distance from human habitations, being driven away before cultivation, and shuns gardens, as pointed out by Forel[21]—although Schenck records its occurrence in such places[11]. The nests and nesting-places of *sanguinea* are very variable, being situated in banks, in rotten stumps, under stones, in clumps of grass, on and in mud walls, under and at the roots of heather, and sometimes small nests will occur under an old boot, or anything lying about.

In summer its nests are often covered with cut grass and other vegetable refuse (Schenck says especially the scales of beech buds)[11]—the débris never forming a hillock, but only a carpet an inch or so high.

On July 30th, 1915, I discovered a large colony at Weybridge situated in and under a heap of hay (cut grass). The heap had the appearance of a mound made of collected vegetable refuse, such as is constructed by *F. rufa* or *F. exsecta*[86].

F. sanguinea is fond of a new nest ; in the summer it selects open sunny places, and in winter more sheltered spots ; this change of nests takes place in very hot dry weather, and also at the approach of winter ; but sometimes it only extends its nest deeper into the ground—this is generally the case with colonies nesting in old stumps. On July 4th, 1914, I found a colony of this ant at Weybridge, situated in a hole in the turf ; on August 3rd they had moved to a nest, about six yards from the former one, at the roots of heather with débris chiefly consisting of chopped heather laid over it. On August 24th I witnessed the ants moving again, carrying their fellows, pupae, etc., to a spot at the root of a gorse-stem some six yards from the heather nest, and by September 15th they had all gone underground for the winter.

Escherich has called the summer nests "work-nests," and the winter ones "rest-nests,"[56] and I have found in Britain that *sanguinea* rarely appears above ground before May, and often retires in September for the winter. The very long hot summer, and the drought of 1921, caused *sanguinea* to disappear before the end of August[92].

A colony may possess three nests, and Forel says they will pass the winter in one of these one year and in another the next[24]. I have found these ants nesting in sandy banks, with or without a covering of vegetable detritus, in grass clumps, in old stumps, and at roots of gorse, etc. (at Woking) ; under and at the roots of heather and in fir-stumps (at Weybridge) ; simply emerging from a small hole in the turf (in Guestling Wood and at Hindhead) ; in the earth on the top of an old mud wall (in the New Forest) ; in

The most interesting fact connected with the life-history of *sanguinea* is its habit of making slaves. This was first discovered and the meaning of these mixed colonies pointed out by Huber, who graphically describes the slave-raids witnessed by him. After having found Ash-coloured Ants mingled with the Sanguine Ants, he was led to suspect that the former were procured by the latter much in the same way as by the Legionaries (*Polyergus*), and he watched their movements from day to day and at length witnessed several of their expeditions. He writes—" The following will convey a just idea of their tactics. On the 15th July, at ten in the morning, a small division of the Sanguine Ants was dispatched from the garrison, and arrived in quick march, near a nest of Negro Ants, situated twenty paces distant, around which they took their station. The inhabitants, on perceiving these strangers, rushed forth in a body to attack them, and led back several prisoners. The Sanguine Ants made no further advance ; they appeared to be waiting some reinforcement. From time to time little companies of these insects came from the garrison to strengthen the brigade. They now advanced a little nearer, and seemed more willing to run the risk of a general engagement ; but in proportion as they approached the Negro dwelling, the more solicitous did they seem to dispatch couriers to the garrison, who arriving in great haste produced considerable alarm, when another division was immediately appointed to join the army. The Sanguine Ants, although thus reinforced, evinced little or no eagerness for combat, and only alarmed the Ash-coloured Ants by their presence. The latter took up a position in front of their nest of about two feet square, where nearly their whole force was assembled to await the enemy. Frequent skirmishes take place all around the camp, the besieged always attacking the besiegers. The Negro Ants, judging from their number, announce a vigorous resistance ; but distrusting their own strength, they look to the safety of the little ones confided to their care, and in this respect show us one of the most singular traits of prudence of which the history of insects can furnish an example. Even long before success is in any way dubious, they bring the pupae from the subterranean chambers, and heap them up on the side of their nest, opposed to that where the Sanguine army is stationed, in order to carry them off with the greater readiness should the fate of arms be against them. Their young females escape on the same side. The danger becomes more imminent ; the Sanguine Ants, sufficiently reinforced, throw themselves in the midst of the Negroes, attack them on all points, and arrive to the very gates of their city. The latter, after a brisk resistance, renounce its defence, seize upon the pupae deposited on the outside and convey them to a place of safety. The Sanguine Ants pursue, and endeavour to steal from them their treasure. The whole body of Negro Ants are in flight ; some few pass through the enemy's

rank, and, at the hazard of their lives, enter once more their habitation, and expeditiously carry off the larvae, that would otherwise remain devoted to pillage. The Sanguine Ants descend into the interior, take possession of the avenues, and appear to establish themselves in the devastated city. Little bands of troops continually pour in from the garrison, and begin taking away the remainder of the larvae and pupae, establishing an uninterrupted chain from one ant-hill to the other : thus the day passes and night comes on, before they have transported all their booty. A considerable number of Sanguine Ants still remain in the Negro residence, and on the following morning, at break of day, recommence the transfer of the rest of its contents. When they have taken away all the pupae and larvae, they then carry each other to the garrison, a few only remaining behind "[3].

Huber goes on to say that eventually the raiders changed their residence, establishing themselves in that of the *fusca* colony, and he describes some other slave-making expeditions, etc. The accuracy of his observations has been confirmed and amplified by Forel and Wasmann in Europe, and by Wheeler with the subspecies *sanguinea rubicunda* in North America.

In Britain during all the years that the habits of ants have been studied, since the observations of Gould in 1747 to the present time, only five records occur of a slave-raid having been witnessed in our country ; it therefore seems advisable to reproduce them in detail. According to Farren-White, Frederick Smith was the first in England to witness the slave-making instinct in active exercise, when he observed a slave-making expedition at Blackwater in Hampshire. Farren-White gives the following account from an unpublished manuscript by F. Smith, in his possession.

" It was in the summer of 1843 I discovered a colony of this slave-making ant, and very closely I watched it, in the hope of witnessing what others had described. Three successive years passed without any satisfactory result. In the nests I found plenty of slaves, or, at least, plenty of a very different species to the *F. sanguinea,* all being black and smaller. One morning, on passing the nest, swarms of ants were spread over the bank in which the nest was situated. The larger ants, the soldiers, were very active, and constantly assuming the most threatening attitudes, standing erect, occasionally springing up on their hinderfeet, and snapping their jaws with great ferocity. The sun burst out, and the whole host rapidly retreated to their subterranean abode. Again, in the evening, I visited the spot, and to my delight I found the army again in battle array. Numbers of the largest ants at length separated from the rest, and formed the advanced guard or van, and the whole body was in motion. At a distance of about twenty yards was a nest of *Formica fusca.* This was the object of their attack. Without the slightest pause, the advanced warriors boldly

entered the nest, and in poured swarms after them. After a few moments had elapsed numbers issued forth, each carrying their slaves in their jaws. Occasionally, a number of black ants rushed out of the nest and gallantly attacked their invaders, but they were quickly overcome, and carried off to the nest of the victors. Frequently, however, they were torn limb from limb, in which case their mangled bodies were borne off, no doubt as food, to the nest. In plundering a nest, although numbers of ants are carried off, by far the greater number convey the pupae, or young brood, of the black ants, and I have some suspicion that it is these which, being born in the nest, become slaves from birth "[41].

In this suspicion Smith was undoubtedly correct, but part of his account is contrary to the usual method of procedure, and it rather looks as if he had written it from memory sometime after the occurrence. Darwin was the next, and he saw what was evidently the finish of a slave-making expedition. He writes—" One evening I visited another community of *F. sanguinea,* and found a number of these ants returning home and entering their nests, carrying the dead bodies of *F. fusca* (showing that it was not a migration) and numerous pupae. I traced a long file of ants burthened with booty, for about forty yards back, to a very thick clump of heath, whence I saw the last individual of *F. sanguinea* emerge, carrying a pupa ; but I was not able to find the desolated nest in the thick heath. The nest, however, must have been close at hand, for two or three individuals of *F. fusca* were rushing about in the greatest agitation, and one was perched motionless with its own pupa in its mouth on the top of a spray of heath, an image of despair over its ravaged home "[34].

Farren-White records that on July 3rd, 1877, when at Shirley with one of his sisters, he secured a nest of *Formica sanguinea* there and—" While carefully examining the *sanguinea* ground—for there were several nests besides the one I had secured—I was not a little interested in observing a worker of *sanguinea* carrying a pupa smaller than the pupae I had appropriated from the captured citadel, and I was still further interested in noticing another worker of *sanguinea* hastening along with a smaller burden, and yet another and another, each laden with what evidently was a precious charge. The little carriers were hurrying forward with a jubilant and triumphant air, and a peculiar cantering motion, and nothing would turn them from their course. Soon we noticed that numbers of *sanguinea* were carrying burdens, a few being larvae, but almost all the burdens were pupae. The jocund little people seemed all eager to reach their home, which as usual was formed around a gorse stump. Some were marching quicker than the rest ; their powers of endurance were evidently greater, and those who lagged behind were perhaps weary with their long journey and with the weight of their burdens, since we could see that they had come

from far. I watched one worker, who travelled thirteen of my paces in three minutes, stopped a little to converse with a slave it met with on its way, and hastened on to its nest. I watched one worker of *sanguinea* travel twenty-three paces or yards, and carry the pupae to its nest. On its way it fairly outstripped two others who were journeying in the same direction and on the same errand. I was determined to trace back the scattered file of *sanguinea* to the spot from whence they had come, and so ascertain from whence they had obtained their precious burdens. I walked back forty-six paces, and discovered that they were filing out of a nest among the fern, and from this nest to their own there was constant motion, constant activity, and constant excitement. But what of the nest which was evidently being pillaged of its infant inmates? There were two workers of *F. fusca* running frantically about upon the surface, with pupae in their mandibles; and, in order evidently to escape from the fell determination of the marauders who were desolating their home, they hurried into the fern, and so endeavoured to ward off from themselves and infant progeny the threatening danger. I opened a portion of the nest, and found a nursery crowded with pupae some depth below the surface of the nest; only one or two workers of *fusca* were left. The rest had evidently escaped with as many of the pupae as they could manage to take charge of and save. I noticed several wandering over the desolated nest with pupae and larvae in their mandibles. I watched a *fusca* carrying off a pupa from behind the entrance whence the *sanguineae* were issuing forth. Immediately it saw one of the enemy approaching, it dropped its charge and left it to its fate. The *sanguinea* then gave it a push, and drove it off in double quick time. I then saw another *fusca* wandering over the nest, and trying to escape, as it were, by the back door, with a larva in its mandibles, but it was seen and overtaken by a small worker of *sanguinea*, who seized the baby from its perturbed and luckless foster-mother, and bore it off in triumph. I noticed a *sanguinea* coming up out of the nest with a pupa; and a *fusca* observing it, went up a fern-frond with the utmost expedition. My sister then observed a tussle between a *fusca* and a *sanguinea*. The *fusca* tried to force an entrance into its pillaged home; but meeting with an antagonist, thought discretion the better part of valour, and turned tail with all speed. These observations were made in the afternoon from 2.30 to 4.20. I now noticed a *sanguinea* take off a pupa from the same entrance into which the *fusca* vainly endeavoured to force its way; and I noticed, further, another pupa within the same entrance; hence was explained the persistence and anxiety of the *fusca*. It had most likely concealed these pupae in the hope that they would be saved from the general wreck. A *sanguinea* had evidently found these out, and the *fusca* was endeavouring to rescue them from their inevitable fate. Several *fuscae* were wandering over the

disturbed nest. One took off a pupa and fled with it in a direction contrary to that taken by the marauders ; at the same time I watched a *sanguinea* frighten off a *fusca*. Another *fusca* met a *sanguinea* on the nest, and ran away precipitately. Another *fusca* then appeared wandering over the nest with a pupa locked in its embrace, knowing not which way to turn for succour and safety. One thing was patent from our observations—that between the *fuscae* and the *sanguineae* there was a well-defined and clearly pronounced antagonism. In presence of the *sanguineae* the *fuscae* were terror-stricken. In fact, the depredators had it all their own way, and were able in this instance, at least, to carry out their marvellous instincts without destroying a single life"[40].

On July 20th, 1908, I had the good fortune to witness a slave-raid, which was taking place early in the afternoon at Bewdley, and which I recorded as follows :—

"I found the ants belonging to a nest situated on a high embankment of the railway in a great state of excitement, all running about outside the nest, and very active in the hot sunshine, some winged females being also present outside. I then noticed that a lot of *sanguinea* workers kept arriving, carrying pupae, whilst others were all hurrying off in the opposite direction. These I started to follow, and found they went along the embankment for a good many yards, and then descended the steep bank, crossed the railway-lines in a slanting direction, and mounted the bank on the opposite side. At the top I found them busily engaged in ravaging a nest of *Formica fusca*. Many workers, laden with pupae, were streaming off in the direction of their home ; I had met specimens carrying pupae all the time I was tracking the outgoing ants. Others were attacking and killing solitary *fusca* workers. Several *fusca* workers were observed up the grass-stems, etc., holding pupae, and endeavouring to escape from the slave-raiders. I watched these proceedings for a considerable time, and accompanied some of the ants with pupae back to their nest, quite a distance off, though they covered the ground very quickly. Several trains passed, but the ants did not appear to be disturbed, as when I went on the lines after one had gone through, the ants continued to cross the railway as if nothing had happened. It was unfortunate that I did not witness the start of the expedition, only arriving after the proceedings were in full swing"[64].

Also on July 15th, 1912, at Weybridge, I observed a number of *sanguinea* workers returning to their nest with *fusca* cocoons in their jaws. A few *fusca* workers were noticed in the neighbourhood in flight and on the top of grass-stems, some with their own cocoons in their jaws, so evidently a genuine slave-raid had taken place[76].

Again on July 30th, 1915, a slave-raid was observed in full swing on Weybridge Heath. The nest of the *F. sanguinea* colony was situated at the foot of a small gorse bush, and I noticed *sanguinea*

workers for 125 paces (all the time meeting others carrying cocoons), when I came upon a *fusca* colony, situated under a gorse root, where *sanguinea* workers were emerging with their booty. I tore up the gorse root and revealed a quantity of cocoons and *fusca* workers, the slave-makers poured in, put the *fuscas* to flight, and carried off all the cocoons[86].

These slave-making expeditions take place in July and August when the males and winged females of the slave species have usually left their nests, and only deälated females, workers, and worker cocoons are present. Both Huber[3] and Darwin[34] assert that males and winged females of the slave species are never met with in *sanguinea* nests, but this is not absolutely the case, as Morice found four males and two winged females of *fusca* in a *sanguinea* nest at Weybridge on July 1st, 1900[47], and Barnes dug up a winged *fusca* female in a *sanguinea* nest at Wellington College on September 6th, 1902[48].

According to Forel raids generally take place at eleven o'clock in the morning, but may occur at twelve, one, or two, and sometimes as late as three or four in the afternoon[24], and not more than two or three expeditions are undertaken by one colony in one year.

The exact position of the slave nest must have been previously ascertained by single *sanguinea* workers, scouting independently, for when the expedition starts the leaders curiously enough keep falling to the rear, others taking their place, and as the ants proceed straight in the direction of the nest to be robbed, a number of workers must all know the way in order to be able to lead the others. They must also possess the necessary memory to find the exact spot again; directions as to advancing, etc., appear to be given by antennae strokes. The workers of *sanguinea* only kill individuals of the raided nests when they meet with considerable hostile resistance, or when the defenders fasten on to their legs. The main idea seems to be to terrify and frighten away their opponents, and thus to obtain possession of as many pupae as possible. Since the number of slaves present in a *sanguinea* colony is never as large as the number of cocoons captured during the summer, it is evident that not all of the latter are allowed to hatch, a number being used as food. Forel has seen a *sanguinea* colony, after pillaging one slave nest, proceed to another eight paces away from the former and fifty from their own nest, robbing this also before returning home[34].

Darwin attempted to explain the slave-making instinct in the following much criticized passage :—

"By what steps the instinct of *F. sanguinea* originated I will not pretend to conjecture. But as ants which are not slave-makers will, as I have seen, carry off the pupae of other species, if scattered near their nests, it is possible that such pupae originally stored as food might become developed; and the foreign ants thus

unintentionally reared would then follow their proper instincts and do what work they could. If their presence proved useful to the species which had seized them—if it were more advantageous to this species to capture workers than to procreate them—the habit of collecting pupae, originally for food, might by natural selection be strengthened and rendered permanent for the very different purpose of raising slaves. When the instinct was once acquired, if carried out to a much less extent even than in our British *F. sanguinea*, which, as we have seen, is less aided by its slaves than the same species in Switzerland, natural selection might increase and modify the instinct—always supposing each modification to be of use to the species—until an ant was formed as abjectly dependent on its slaves as is the *Formica rufescens*"[34].

In spite of opinions to the contrary this is an accurate statement of what does take place, for, as we have seen, other ants besides the slave-makers do raid strange nests and steal the pupae for food (*Acanthomyops fuliginosus*, *Myrmica*, etc.), and will occasionally actually bring them to maturity. *F. sanguinea* has not lost the instinct or power of working, both in the construction of their nests and in bringing up and attending to their brood, and indeed can live and prosper without slaves at all; hence they have been called facultative slave-holders. Wasmann has suggested that fewer slaves are present in the largest and oldest colonies, and that when a colony is old enough it ceases to make slave-raids[62]; but this is not proved to be always the case.

D. Sharp says *sanguinea* very frequently lives without slaves[44], but this is hardly the fact, at any rate in Europe. Forel mentions that in Switzerland he has seen a few colonies of *sanguinea* without slaves[24], and Wasmann says that in Holland such slaveless colonies are very rare[35].

Forel, when recently describing a very large community of *sanguinea* without slaves, records that only three or four times in his life has he ever before found *sanguinea* without slaves. At the Chalet Boverat below Lausanne in a large meadow he discovered forty *sanguinea* nests, two to five metres distant from each other, over a length of over one hundred and fifty metres, all connected by chains of ants, and not a single slave occurred in any of them. He thinks it probable that the *sanguinea* had exterminated all the *fusca* species in the neighbourhood, as he was unable to find a single nest anywhere near[74].

I have only twice found a *sanguinea* nest in Britain which did not contain slaves, and the suggestion that our species is less aided by its slaves than those in Switzerland appears to me to be very doubtful.

On May 25th, 1918, a very large populous colony of *F. sanguinea* was found at Woking situated in the stump of a large fir tree, and after the most careful search no *fusca* workers were found in the

nest[90]. The second occasion was also at Woking, where on May 26th, 1923, in a pseudogyne nest which contained over twenty queens, not a single *fusca* slave could be found[93].

Wheeler points out that the normal slaves of *F. sanguinea* are members of the *F. fusca* group, namely, *fusca*, *glebaria*, *rubescens*, *gagates*, *rufibarbis*, and *cinerea*, but it occasionally enslaves members of the *rufa* group (*rufa*, *pratensis*, and their varieties). He says there can be no doubt that the typical *fusca* is the form most frequently enslaved in Northern Europe and at high elevations in the Alps, but in the valleys of Switzerland the varieties *glebaria* and *rubescens* and *F. cinerea* are the commonest slaves[69].

Wasmann found that in Holland *fusca* was the most common slave-species[35], but that in Luxemburg *rufibarbis* was more generally used[62].

Two *fusca* forms may be present in one *sanguinea* nest, or even *fusca* and *rufa* forms together.

On July 27th, 1875, Forel observed a *rufa*-like nest on the side of a road near Laegern which on examination proved to contain both *sanguinea* and *rufa* workers, the latter being a little more numerous than the former, and generally small in size, and no *fusca* workers were present[26]. Wasmann, on the other hand, found a *sanguinea* colony at Exaeten in which 10 per cent of the slaves were *rufa*, and 5 per cent *fusca*[35].

In the summer of 1886 Forel discovered a *sanguinea-pratensis* colony at Fisibach in which the former were of large size and more numerous than the latter, which were small in stature[32]. Wasmann has also observed *sanguinea* colonies which contained only *pratensis* as slaves, as well as colonies with both *fusca* and *pratensis* as slaves ; but a *sanguinea-fusca-pratensis* colony described by Rüschkamp is a rather more complicated affair. In April, 1911, he knew of a normal *sanguinea-fusca* colony, which was partly dug up May, 1911, and February, 1912, and on each occasion a *sanguinea* queen, some workers, and slaves were taken for observation purposes. In August, 1912, *pratensis* workers were found to be present in the nest, and on completely digging up the same, a deälated *pratensis* female was found, which must have been adopted by the queenless *sanguinea-fusca* colony[80].

In Britain *F. fusca* is undoubtedly the usual slave species utilized, indeed I have never found any other *fusca* form present in *sanguinea* nests in nature, and only once any other slave ; when at Rannoch I took specimens of *F. rufa* var. *alpina* in company with *fusca* in a *sanguinea* colony situated in a locality where *alpina* nests occurred[75].

F. Smith says he has found *cunicularia* in *sanguinea* nests in England[16], though he gives no dates or localities for the same, but there is no reason why this should not be the case, for *sanguinea* enslaves the *fusca* species that happens to be living in the same district.

I have placed in my *sanguinea* observation nests worker cocoons of *F. fusca, glebaria, rufibarbis, rufa,* and *pratensis,* all of which have been taken into the nests, some of each having been allowed to come to maturity and act as slaves.

D. Sharp says that *sanguinea* "possibly utilizes *Lasius flavus*" as a slave in England[44]; he probably made this statement because F. Smith has published that he had found *flavus* workers in *sanguinea* nests[16]. In 1843 the latter author records that one evening he saw some *sanguinea* workers pillaging nests of *A. niger* and *A. flavus* at Cove Common, carrying off their workers and pupae; this he concluded was a slave-raid[4]; and Schenck says he has found *A. alienus* workers and pupae in *sanguinea* nests at Nassau[10]. Forel criticizes the belief of Schenck and Smith that *sanguinea* makes slaves of *alienus* and *flavus* pupae, remarking that this was a complete error, *sanguinea* always devouring the *Acanthomyops* pupae given to them[24].

Forel further points out that *sanguinea* workers often attack *niger* and *flavus* nests and amuse themselves by killing the inhabitants[24], and Wheeler writes:—"Even *sanguinea* shows a tendency to lapse into the ancient instinct of plundering the nests of different species of ants indiscriminately"; he describes as ridiculous a foray of a large *sanguinea rubicunda* colony on a woodland variety of *Myrmica scabrinodis* he witnessed in America[52].

On July 10th, 1912, I myself observed an attack by *sanguinea* on a colony of *A. umbratus* at Weybridge, the nest of the latter being situated under a gorse root some twelve paces away from that of the former. A row of *sanguinea* workers stood outside the *umbratus* nest on guard, while others had penetrated under the root, and a large number of dead *umbratus* were lying about, and many of the *sanguinea* had dead workers of the attacked species fastened to their legs and antennae[76].

Forel records that one fine day he saw a thick column of *sanguinea* workers march to a *pratensis* nest, drive off the latter and steal their large male and female cocoons, which they devoured, but, as he suggests, had they been worker cocoons some of them would probably have been taken home to be brought up as slaves[22].

Various authors have recorded finding species of ants, other than slaves, in *sanguinea* nests, and Rothney took *A. niger, A. flavus, M. scabrinodis, M. ruginodis, M. lobicornis, Leptothorax acervorum, L. nylanderi,* and *Tapinoma erraticum* in such situations at Shirley[18].

In some of these cases no doubt the alien species were living near to the *sanguinea,* and as Forel has pointed out, what appeared to be mixed nests were really only compound nests. I have twice found a *Tapinoma* nest quite close to a *sanguinea* nest at Weybridge, in fact the former might almost be described as being situated in the latter, but *Tapinoma* can well protect itself with its

repugnant discharges, and the *Formica* would leave it strictly alone ; and I have also several times found nests of *Myrmica lobicornis* situated beneath nests of *F. sanguinea* in the same locality ; and species of *Leptothorax*, as we have seen, often associate with other ants, but none of these examples represent the phenomenon of dulosis in any way.

According to Huber the slaves are better qualified than their masters to take care of the larvae, and to them is entrusted this important duty ; he also says they close and open the doors of the nest[3], but we have already seen *sanguinea* is well able to carry out all these actions unaided. When migrating the masters carry their slaves, and if a nest be disturbed the largest *sanguinea* workers rush out to see what is happening, threatening with open jaws, the large specimens often acting as sentinels at the doors. I had a large *sanguinea* worker (recognizable because it had lost one of its antennae) which always undertook these duties.

The slave-owners spend a large part of their time attending *Aphidae* on trees and bushes and in hunting small ants and other insects ; I have found amongst other remains in a *sanguinea* nest the body of a large " Humble Bee ".

It has been suggested that the slaves do not leave the nest of their own free will, and Darwin says that Smith informed him he had never seen the slaves either leave or enter the nest[34], but this is not always the case. Darwin himself records that during the month of July, 1860, he came across a community with an unusually large stock of slaves, and he observed a few slaves mingled with their masters leaving the nest and marching along the same road to a tall Scots fir tree, twenty-five yards distant, which they ascended together, probably in search of aphides or cocci[34]. I have frequently seen *fusca* workers coming in and going out of their owners' nests, and foraging near.

The winged sexes of *sanguinea* may be found in the nests from May to September. Schenck records males as met with in a nest at Nassau on May 19th, 1852[12], and both sexes in other nests from July 9th to 18th[11]. Forel gives the middle of June to the end of July[25], and Wasmann the middle of May to July, and he says males and females are seldom found in the same nest at the same time[50], but Smith found all the sexes in the nest in August[15]. I have found males only in nests at Woking and Weybridge in July, August, and September, winged females in plenty in nests at Woking on June 29th, 1912, and males and winged females together in the nests at Bewdley on July 20th, 1909, etc. On September 5th, 1913, I took some micraners, only 6 mm. in length, at Weybridge ; at Bewdley on July 20th, 1919, micraners[64] measuring 7 mm., while the largest male met with in that locality was 10 mm. in length. Lomnicki records that he found micraners of this ant in a nest at Lemberg in Poland, which also contained the

beetle *Lomechusa strumosa*; and he attributes the occurrence of these small males on this occasion to the presence of the beetle[91]. Escherich mentions *sanguinea* females with short wings[55], which from what we know of such cases in *Acanthomyops*, etc., may be mermithogynes; Wasmann records workers of the size of normal females, but with broader thorax and shorter wings, which he classes as gynaecoid macropseudogynes[50].

Three gynandromorphous specimens of *sanguinea* have been recorded. Tischbein[8] found an ergatandromorph in a *sanguinea* nest on July 28th, 1851, at Herrstein, in which males but no winged females occurred. This may be described as follows :—

Nearly complete lateral ergatandromorph; male on left, worker on right side. In the head, the left mandible, outer third of clypeus, antenna, eye, median and lateral ocellus, are male, though the black colouring also covers the smaller right ocellus. Remainder of head red (worker). Thorax and petiole male on left, worker on right, the line of division being median on the dorsal surface, and the structure of the meso-, meta-, and epinotum correspondingly asymmetrical. Left half of thorax black, right half red, sharply divided above; on the ventral surface the dividing line is median only on the prothorax but passes outside the middle and hind coxa on the male side. Petiole sharply divided into a black male (left) and a red worker (right) half. Gaster black, with a large red blotch on the right side at the base of the first segment. The pilosity and sculpture of the left side are male, those of the right, worker. External male genitalia are present on the left side and the anal sternite is present only on this side. Remaining organs of this region quite malformed. All the legs, and the coxae of the male side, are red and hence of the worker type. Wings of the male (left) side of normal size, but their veins and stigma are paler. There are no wings on the worker (right) side.

This appears to be the first description of a gynandromorphous ant. When examining *sanguinea* nests at Bewdley I had the good fortune to meet with an ergatandromorph on July 20th, 1909, and a gynandromorph on the following day, both in the same colony; these I described thus :—

"Nearly complete lateral ergatandromorph; male on right side, worker on left. Right antenna male, left worker. Right mandible, eye, lateral ocellus, and median ocellus male; left mandible, eye and lateral ocellus worker. The head is black, with the exception of the left mandible, left half of clypeus, a small patch before left eye, and left cheek, which are red. Thorax and petiole male on right, worker on left, the line of division not being quite straight however, the black colour on the right side of the mesonotum encroaching on the red colour of the left side. Petiole divided sharply, black on right, red on left side. Gaster black, the right half with male pilosity and sculpture, left half worker. External male genitalia are present on the right side, the anal sternite being present only on that side. The red and black colour is sharply defined beneath, but the coxae are all black and red as in the male, and the legs on both sides are somewhat infuscate, the tarsi on the right side being longer. Winged of course only on right side, the veins and stigma are pale, and more like those of the female. *Long.* 7 mm."[64].

"Lateral gynandromorph; male on left side, female on right. Both antennae female, head somewhat small, but female shape, left eye a little larger than right, ocelli female. Head black, with exception of clypeus and

right mandible, which are red ; greater part of thorax red and black, evenly divided laterally, only the top right corner of the epinotum being red. A bit of the scutellum and post-scutellum on the left side where the wing is joined, red. Petiole sharply divided, red on right side, black on left. Gaster black, the right side with female pilosity and sculpture, left side with that of male. Colour sharply defined underneath. Legs and coxae female on right side, male on left. External male genitalia are present on left-hand side. Fully winged on both sides, the stigma and veins being darker, as in the male. *Long.* 9 mm."[61].

On June 12th, 1914, I dug up in a *sanguinea* nest at Woking a curiously deformed partly winged female. The right posterior leg is short, and deformed, the femur being short and abruptly bent, the tibia short, and the tarsus twisted and deformed. The tarsal claws are short and blunt, being almost absent. The right fore-wing, though broken, was still present, which would appear to show that this female dated from, not less than, the year previous to that of capture. The formation of the leg may be due to an injury received during an earlier instar[92].

André gives June and July for the marriage-flight of *sanguinea*[28], and Schenck July[11], while Smith suggests August[17]. Forel saw the males and winged females leaving a nest at Vaux from seven to eight o'clock in the morning on July 3rd, 1873[25] ; I have found winged females away from their nests at Bewdley on July 20th, 1909.

Pseudogynes of *sanguinea* have been observed in numbers, and Wasmann attributes the occurrence of these entirely to the presence of the beetle *Lomechusa strumosa* in their nests.

I shall not discuss the subject fully now, hoping to deal with it at length on a future occasion, and shall therefore only give the results which Wasmann deduces from his observations on the occurrence of these forms, and my own experience, such as it is, with these curious individuals. He has studied and described numerous forms of them, in Holland and in Luxemburg, and he says :—

(*a*) The pseudogyne district always coincides with the *Lomechusa* district.

(*b*) The pseudogyne-holding colonies are always the centre of the *Lomechusa* district.

(*c*) Outside the *Lomechusa* district pseudogynes are never found in *sanguinea* colonies.

(*d*) In colonies where *Lomechusa* only dwells as an imago, pseudogynes are not produced, but rather only in those in which *Lomechusa* has brought up its larvae for many years[49].

On May 22nd, 1908, I found pseudogynes in plenty in a colony of *F. sanguinea* in the New Forest, but after having dug up the whole nest, the most careful examination of it on a large white

sheet failed to produce either *Lomechusa* or its larvae[59]. This appears to be the first time a pseudogyne has been found in Britain, nor have I been able to detect such specimens in any of the British collections which I have examined. This is the more remarkable, as pseudogynes are very conspicuous objects, especially those of *sanguinea*, with their hunch-backs and usually lighter colour.

On May 25th, 1906, I discovered *Lomechusa strumosa* in a *sanguinea* nest at Woking, no pseudogynes being present, and I have observed this beetle for a number of years in various nests throughout the *sanguinea* area, which is not large in that locality. On May 17th, 1907, I found over sixty specimens of the beetle in a single nest, and for several years I bred it in my large observation nest at home. During all this time, until 1913, not a single pseudogyne was observed at Woking, although specially searched for. In 1913 the beetle appeared to be very scarce, I only saw a single specimen, but on May 12th two nests of the ant situated near to each other contained pseudogynes, quite 10 per cent of the ants in one of them consisting of this form[82]. These nests were most carefully dug up, but neither *Lomechusa* nor its larvae could be found, and the ants, and débris of the nests, were replaced in their original situations. On June 12th, 1914, two colonies of *sanguinea* were found, their nests occurring in almost the same spots as in the previous year; both contained pseudogynes, though not so plentiful as in 1913, and in one of them two or three *Lomechusa* larvae were present, in the other over a dozen.

These two nests were dug up again on May 27th, 1915—the one contained two queens, very many workers, and larvae, and some 10 per cent of pseudogynes, and the colony appeared to be in a flourishing condition; the other consisted of a few pseudogynes, workers and larvae, but no queen was present, and the colony was neither populous nor flourishing[86]. On May 10th, 1916, these two colonies were found to have joined forces, one large nest only being present, forming a flourishing community. It contained a large number of pseudogynes, great numbers of ordinary workers, egg-masses, and over a dozen *Lomechusa strumosa*. A queen, a number of workers, pseudogynes, packets of eggs, and six *Lomechusa* were taken home and fixed up in a four-chambered "Janet" nest[88]—a brief account of which follows shortly. To continue the history of this pseudogyne colony in nature—On August 17th, 1917, it was again visited, and the nest was found to be in the same spot it occupied the year before. Numerous cocoons were present, and some of these were taken home and introduced into a *sanguinea* observation-nest, and when they hatched later some of them proved to be pseudogynes[89]. Again, on May 25th, 1918, the colony was found to be in a flourishing condition. It contained three deälated females, numerous workers, and pseudogynes, but only a few larvae were seen. This, however, was the case with all the *sanguinea*

colonies that year, as they appeared to be very late as regards the brood[90]. On May 26th, 1923, this pseudogyne colony was found to be situated in the same spot (I have never found pseudogynes in any of the other nests scattered over the Woking district). It contained over twenty queens and about 7 per cent of the ants present were pseudogynes. It was in a prosperous condition, and had flourished to my knowledge in the same spot for over ten years[93].

The *sanguinea* queen in the observation-nest mentioned above laid eggs on May 13th, June 3rd, etc., in 1916. On June 20th I introduced a number of *sanguinea* sex pupae, and packets of eggs from Bewdley, which were all taken in by the workers and pseudogynes. This appeared to have annoyed the ants, as although they were supplied with plenty of animal food and honey, by July 1st they had devoured all the sex pupae, eggs, and their own brood, and had killed all the *Lomechusae*, some of which had been cut up. On July 8th I introduced worker cocoons of *F. fusca* and *F. rufibarbis* from Weybridge to act as slaves; most of these were allowed to hatch and live in the nest, but the queen did not lay again until 1917. The pseudogynes behaved in the same manner as ordinary workers, helping to kill and cut up prey, etc. etc[88].

In 1917, 1918, and 1919 a number of normal workers were reared from eggs laid by the queen. As no pseudogynes were produced from the eggs of this female, it shows at any rate that pseudogynes are not the result of pathogenic conditions in the egg, or mother queen[93]. The pseudogynes gradually died off, the last dying on July 7th, 1918, having lived in the nest for over two years. The queen died on July 17th, 1919, when the remaining workers were let loose in the garden.

For a number of years Wasmann kept statistical charts of very large colonies (consisting of many nests) of *sanguinea*, and every credit should be given to him for these exhaustive observations, although my experience which, after all, only consists of more or less negative evidence, does not appear altogether to support his theory. The number of deälated females of *sanguinea* present in any nest varies considerably at different times: in 1912 I was unable to find a wingless female, when badly wanted for experiments, though the winged females were abundant; but in 1913 deälated females were present in every nest—in one I counted no less than thirty-seven[82].

Forel states that eggs are first laid by the queens in April[25], but in captivity I have observed the latter to lay as early as January and February, no doubt on account of the higher temperature of my room.

In queenless nests the workers of *F. sanguinea* lay large quantities of eggs (at any rate in captivity)—the greater number of these eggs are devoured, but those which have come to maturity have (according to Forel, Lubbock, Wasmann, and Viehmeyer) only produced

males. Crawley thinks that workers were produced in such a nest in his possession, but he is now making further more careful experiments.

In quite young colonies workers only are reared, the males and females only appearing when the colony has reached a certain age; afterwards worker cocoons occur, chiefly from July to September, but they may occasionally be present, earlier or later, in June and October. Male and female cocoons which I collected in a nest of this species at Rannoch on July 16th, 1913, hatched during the same month. The pupae are usually enclosed in cocoons, but Schenck records finding naked pupae at Nassau[9], and I found a number of the latter in a nest at Weybridge on July 22nd, 1911.

We have seen that females of the *rufa* and *exsecta* groups are unable to found their colonies alone—the females of the *sanguinea* group are usually incapable of founding such colonies. In 1909 I took a number of fertile females, from Woking, Aviemore, and Bewdley, and isolated them in bowls, with damp sponges and sand, where they remained for months without laying or excavating in the sand, and eventually died[71]; and again in 1910, under similar conditions, fertile females from Woking laid eggs which were left scattered about; these were never attended to, and did not hatch, the females dying[73]. Viehmeyer made similar experiments in 1909, with the same results[66].

As we have seen, colonies of *F. sanguinea* often spread over a large area, branch and twin nests being formed, and young females are received back into the nests.

One of my observation-nests of *sanguinea* was obtained from Woking in 1910, and when the queen died the next year I collected some more females at Woking and introduced one of them on May 5th, 1911. She was at once accepted by the *sanguinea* and their slaves, and having lost one antenna and two legs by injury when digging up the nest, was always recognizable. On May 27th, 1911, I introduced a second female, also from Woking but taken from another nest; this also was accepted, as was also another female taken at Woking in June, 1913, and introduced into the nest on December 30th, 1913. All these three females laid eggs every year and lived as queens in this nest until April, 1914, when the whole colony perished.

In 1905 Wheeler pointed out that although isolated *sanguinea* queens are often seen running about on the ground and seeking suitable nesting sites, no one had been able to show that these insects can found colonies without the assistance of alien workers, and he stated that a *sanguinea* queen very probably establishes her colony in a depauperate nest of an auxiliary species[52]. Subsequently in 1906, Wheeler proved the possibility of his suggestion by experiments, with the American subspecies *rubicunda* [Bull. Amer. Mus. NH. **22** 33–105 (1906)], and in 1913 he says that in Europe " Vieh-

meyer, Donisthorpe, and Wasmann have shown that the female *sanguinea* establishes her colony by entering a *fusca* nest, appropriating some of the pupae and killing or driving away any of the *fusca* workers that venture to attack her or seek to deprive her of her booty. She guards the kidnapped young, and eventually helps then to hatch, thereby surrounding herself with a troop of nurses for her own brood as soon as she begins to lay. This method of colony formation in the typical *sanguinea* is the same as that first described by myself [W. Wheeler] for our American subspecies *rubicunda* and *subintegra* "[79].

Since Wheeler first suggested how *sanguinea* queens found their colonies, a number of observations in nature and experiments with captive ants of these species have been published, making us acquainted with the different stages of colony founding.

In the summer of 1898 Schmitz saw a female *F. sanguinea* endeavouring to enter the different doors of a *F. fusca* nest, near Exaeten, going in by one door, then coming out and re-entering by another, and so several times backwards and forwards; the numerous *F. fusca* workers about did not hinder her, but Schmitz is now unable to remember if she was finally accepted[61].

On July 29th, 1916, near Wellington College, I observed a deälated *sanguinea* female running on the ground near the nest of a *fusca* colony; no *sanguinea* nests occurring within a mile of the spot where I was. This was a good instance of the case when a *sanguinea* female after the marriage flight finds herself far removed from a colony of her own species, and sets about to find a *fusca* nest in which to found a colony[88].

Wasmann records that he once found at Exaeten in Holland a dead *sanguinea* female in a *rufibarbis* nest, held by the legs and antennae by a number of the *rufibarbis* workers[61]. On September 15th, 1887, he observed at Exaeten a small *sanguinea-fusca* colony in which the *sanguinea* workers were all small and not fully coloured, their numbers at the most not exceeding a hundred individuals, while the *fusca* workers to the number of about two hundred were all large and mature, the only queen present being a *sanguinea* female[51]. Again on May 23rd, 1889, in the same locality, he discovered a very small colony consisting of only ninety *fusca* workers, a *sanguinea* queen, and five freshly hatched workers of the latter[51, 61].

In the spring of 1909 Forel, when in company with Wheeler and Viehmeyer, found in Valais, under a stone, two fertile *sanguinea* females in the middle of a small heap of cocoons of *F. rufibarbis* and some workers of the latter, the little colony also containing a dozen small *sanguinea* workers, which were older than those of the *rufibarbis*[65].

Viehmeyer also records the last observation, and in the middle of August of the same year, near Dresden, he found under a stone

in a small earth-hole a *sanguinea* female, two very small *sanguinea* workers, and three equally small *fusca* workers. On searching further, a *fusca* female was discovered, two more *fusca* workers, and some pupae. This made him think of an alliance between the *sanguinea* and *fusca* females, as the workers of the former were certainly not younger than those of the latter. He put a *sanguinea* and *fusca* female together, and in four days they were quite friendly together, but subsequently the nest went wrong, and they both died on the same day[66].

In 1911, 1912, and 1913 I tried numerous similar experiments, all of which were failures, for although the strange females generally become friendly, resting side by side and cleaning each other, etc., and often living together for months, before any results were obtained one or the other has died.

On July 3rd, 1913, Crawley found a *sanguinea*-*fusca* colony (situated in a tree-stump at Weybridge) consisting of an equal number of workers and cocoons of both species, the *sanguinea* all being small. He took as many of the pupae as he could obtain, which subsequently hatched and produced thirty-five *sanguinea* workers and thirty-four *fusca* workers. The situation of the nest prevented him from digging it up properly to ascertain if a *fusca* queen was present as well as a *sanguinea*[83].

On May 1st, 1914, Pinkney discovered a small colony at Woking (situated in a bank) which consisted of a *sanguinea* queen, sixty to eighty very small *sanguinea* workers, and three *fusca* workers[84]. The six cases mentioned above are, as far as I am aware, all the incipient colonies of *F. sanguinea* that have been recorded in Europe.

In 1910 Wasmann enumerated the following six ways in which he suggests fertile *sanguinea* females may found their colonies :—

1. With the help of workers of their own colony : by branch nests.
2. With the help of workers of a strange colony of their own species : by the adoption of the female into a strange colony.
3. With the help of grown-up workers of the auxiliary species : by the adoption of the *sanguinea* female into independent colonies of *fusca* or *rufibarbis*.
4. With the help of worker pupae taken by force from the auxiliary species : colony-founding by a pupa raid.
5. With the help of pupae of the auxiliary species, which *sanguinea* workers had left behind when plundering a slave-nest : colony-founding with pupae found. [After a slave raid at Lippspringe which Wasmann observed on July 21st, 1919, he found a number of *fusca* pupae left behind which the *sanguinea*

workers had either forgotten or intended to come back for, and in any case he suggests a *sanguinea* female wandering about after the marriage-flight might easily have discovered them and appropriated them to bring up her brood when hatched. This is quite feasible, for when I introduced *fusca* pupae to some of my isolated *sanguinea* females they sometimes collected them and rested on the top.]

6. With the help of females of the auxiliary species, when a *sanguinea* and a *fusca*, or *rufibarbis*, female find themselves together after the marriage-flight: colony-founding by Allometrose[68]. [Wasmann's allometrose=an alliance between females of different species or races to found a mixed colony.]

A number of experiments have been carried out, in captivity, on the behaviour of *F. sanguinea* females, when introduced to colonies of *F. fusca* and its races, but only a few can be given here to illustrate what takes place.

In 1909 I carried out some thirteen experiments, only two of which were successful, in all the others the *sanguinea* female was either killed at once by the *fusca* workers or died subsequently from injuries received from them. One difficulty in these experiments is that it is not possible to provide a means for the female to escape, as she could under natural conditions. In order to test this question in the most exhaustive manner, we require a young female just after her marriage-flight, and also a small, or impoverished, *fusca* colony, both of which are exceedingly hard to find, especially just when wanted. I therefore made up small colonies of *fusca*, and its var. *glebaria*, by putting a limited number of workers and pupae into a combined "Fielde and Janet" nest, and introduced *sanguinea* females. I used both old deälated and doubtless impregnated females, and young winged virgin females, taken from *sanguinea* nests. From the latter I removed the wings, as Wheeler has shown that when the wings of a *Formica* female are removed, she acquires the instincts of an impregnated female.

No. 1. A small colony of *F. fusca*, consisting of workers and larvae taken at Sherwood Forest on June 13th, 1909.—June 24th, a *sanguinea* female, taken in a nest at Aviemore on May 17th, was introduced. She still retained one wing, which was removed. The *fusca* workers ran away when the female first approached them, but later attacked her. She retaliated by biting, and in the evening they were still fighting. The female did not pay any attention to the larvae, and did not try to conciliate the workers, but ran away from them.—June 25th, five workers had been killed by the female, and the remainder were in the passage between the two compartments with the larvae.—June 27th, the workers still occasionally attacked the female, several of them were killed.—

June 28th, the female appeared to be accepted by the workers, as they were all resting together, and several were cleaning the female.—July 2nd, the female was dead, no doubt from injuries received in the previous encounters.

No. 2. July 4th, 1909, introduced a deälated *sanguinea* female taken at Woking, May 5th, into a small *fusca* colony with pupae. The female approached the pupae, tapped them with her antennae, and was evidently much interested in them. The workers removed the pupae, but the female was only slightly attacked, and repulsed the workers. A little honey was given to the ants, and the female and workers fed side by side.—July 5th, the female had collected all the pupae into a corner and rested on them ; two workers were with her, but several others were dead and injured.—July 6th, the female was on guard over all the pupae in one corner, and all but three of the workers had been killed. They tried to remove the pupae one by one, but the female brought them back again. Some pupae and larvae from a *fusca* nest from Weybridge were introduced, and the female collected them all together into her corner.—July 15th, only two workers not killed, these were quite friendly with the female, all resting together on the pupae. All went well, and they all remained on friendly terms till the termination of the experiment.

No. 9. On July 12th, 1909, Hamm sent me a small *fusca* colony from Shotover, near Oxford, which contained many pupae and workers.—On July 23rd the wings were removed from a virgin *sanguinea* female (taken at Bewdley) ; she was first placed in a tin with some pupae, and afterwards introduced into this colony on July 24th. She killed two workers, which attacked her, and later captured some of the pupae, on which she rested in a corner, the workers collecting the remainder into another corner. Later she injured a worker, killed another which fastened on to her leg, and captured more of the pupae.—July 25th, all the workers but one were killed, the female resting on all the pupae in a corner.—July 26th the female carried the pupae about and arranged them all together. A few *glebaria* workers were introduced into the nest, and when these approached the pupae the *sanguinea* female sprang forward, seized and shook them, as a terrier shakes a rat, killing them all. This experiment differed slightly from the previous one in that the female killed all the workers, and took possession of all the pupae[71].

In none of the thirteen experiments when a *sanguinea* female was introduced into a *glebaria* colony was she accepted by the workers ; she was always killed by them, generally the same day.

In one of my experiments carried out in 1912 the result demonstrates how powerfully a female *sanguinea* can resist when attacked, and where if she had been living in nature she might possibly retire

and escape. On July 10th a *sanguinea* female sent to me by Martineau from Bewdley was placed in the light chamber of a nest containing a strong colony of *F. fusca* from Porlock, and blocked in by herself with cotton-wool as I was going away for a couple of days. On my return on July 13th I found the *fusca* workers had forced an entrance, the *sanguinea* female was dead, and no less than fifteen dead *fusca* workers lay beside her[78].

The next two experiments show that not only do artificially deälated virgin females exhibit the same instincts as newly fertilized self-deälated ones, but that they also lay eggs.

On July 2nd, 1912, I removed the wings from a young virgin *sanguinea* female taken at Woking in a *sanguinea* nest, in which no males were present. She was introduced into the light chamber of a small plaster-nest with two divisions, the dark chamber of which contained seven *fusca* females, three *fusca* workers, a few larvae and one cocoon. (This small brood had been brought up by these ants, which had been taken from a *fusca* colony at Hynish, Tiree, in April.) The *sanguinea* female soon entered the dark chamber ; the *fusca* females and workers ran away and hid in corners, and later in the day all but one female had gone into the light chamber, taking the larvae with them, but the *sanguinea* female had captured the cocoon, which she held in her jaws. On July 3rd all the *fusca* workers had been killed and the *sanguinea* female was again holding the cocoon in her jaws, the *fusca* females being all huddled together in one corner with the larvae. July 4th, one of the *fusca* females had been killed, and the *sanguinea* female had collected the two largest larvae and the cocoon. Four of the *fusca* females were now removed, being required for other experiments. July 5th, the two remaining *fusca* females had been attacked, one having had both her antennae bitten off, and on July 7th both were dead and the *sanguinea* female was resting on the cocoon and the two larvae. July 8th, a naked pupa from a *fusca* nest from Porlock was introduced, and the *sanguinea* female added it to her collection. July 9th, the female still resting on her heap, ten *fusca* cocoons were introduced ; these she also collected and placed with the others. July 13th, the Tiree cocoon produced a callow, and the empty case had been carried into the next compartment. The largest larva had changed into a naked pupa, and the *sanguinea* female and the callow were resting together on the other cocoons and on the two naked pupae and the small larva.

July 14th, another empty pupa case was found in the light compartment, but as no second callow had hatched, the female must have eaten its contents. July 15th, a second callow emerged, and on the 17th a third, whilst a single egg was present. July 18th a fourth callow appeared, and the egg had vanished, the female was still helping to carry about the cocoons[78], and by August 10th eleven *fusca* workers had hatched. During the whole of 1913 nothing

of moment happened in this small colony ; a *fusca* worker escaped on March 18th ; one died on September 1st and two more on November 5th ; two more workers died before January 20th, 1914, three more in February and another in March. On April 4th the *sanguinea* female had laid a small packet of eggs, and on the 10th she was holding them in her jaws, the one remaining *fusca* worker resting beside her. On April 15th the eggs had disappeared, but on the 17th more were laid, and the worker carried them about. The number of eggs increased, but they did not hatch, and on May 25th they were found to be mouldy, so I transferred the queen and the worker to a small " Crawley-Lubbock " earth-nest. On June 2nd, 1914, when I introduced a few small *fusca* cocoons, hoping the queen might lay again and have a larger family of workers to look after her eggs, she was unfortunately crushed and died two days later.

On July 25th, 1912, Crawley placed an artificially deälated virgin *sanguinea* female in a glass-topped box containing two workers, a number of pupae, and a callow of *glebaria* from the New Forest, when the two adult workers each seized a pupa and fled to the top of the box, where they remained, holding the pupae for two days without having been observed to move. The *sanguinea* female took no notice of either workers or pupae until the next day, when she collected the pupae together and rested on them with the callow ; more callows hatched from day to day ; the two mature workers were found dead on July 28th. By the 31st there were ten callows with the female on the pupae and all were on good terms[78]. Crawley told me that all the pupae hatched, and that the female laid eggs in the spring of 1914, and later a pupa and some large larvae were alive ; these were presumably the brood of the *sanguinea* female. Wasmann performed some experiments with young fertile *sanguinea* females and found that *fusca* workers adopted them readily, but Viehmeyer, and subsequently Wasmann himself, found that *sanguinea* females pillaged the cocoons and killed the *fusca* workers. It would therefore seem that this violent method is the more usual.

If Darwin had known, as we know to-day, that the queen *sanguinea* does not herself found her colony, but from the very first steals the *fusca* pupae, one of his greatest difficulties would have been removed, viz. why it is that workers, which do not normally breed, inherit the slave-making instinct[72].

The following myrmecophiles have been taken with *F. sanguinea* in Britain :—

Coleoptera : *Oxypoda recondita* Kr., *O. haemorrhoa* Sahl., *Dinarda dentata* Gr., *Lomechusa strumosa* F., *Myrmedonia limbata* Pk., *Drusilla canaliculata* F., *Notothecta flavipes* Gr., *Lamprinus saginatus* Gr., *Quedius brevis* Er., *Othius myrmecophilus* Kies., and *Hetaerius ferrugineus* Ol.

Formicidae : *Leptothorax acervorum* F., and *L. nylanderi* Först.
Ichneumonidae : *Pezomachus intermedius* Förest.
Braconidae : *Pachylomma buccata* Nees.
Proctotrupidae : *Proctotrypes gravidator* L.
Diptera : *Pseudacteon* (=*Phora*) *formicarum* Verrall.
Heteroptera : *Alydus calcaratus* L. (larva and nymph), *Nabis lativentris* Boh. (larva), and *Pilophorus perplexus* D. and S.
Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic.
Araneina : *Evansia merens* Camb., *Micaria pulicaria* Sund., *Miscarisoma festiva* C.K., *Dysdera cambridgei* Thor., *Harpactes hombergi* Scp., and *Theridium riparium* Blkw.
Acarina : *Laelaps* (*Hypoaspis*) *myrmecophilus* Berl., *L.* (*Cosmolaelaps*) *cuneifer* Mich., and *Laelaps* (*Oolaelaps*) *oophilus* Wasm.
Crustacea : *Porcellio scaber* v. *rufa* Bagnall, and *Platyarthrus hoffmanseggi* Brdt.

Formica fusca L.

Formica fusca Linnaeus Syst. Nat. (Ed. 10) **1** 580 (1758)[1]. [" Grande Fourmie noire " De Geer Mém. Hist. Ins. **2** 1082 (1771)[2].] *Formica nigra major* Retzius Gen. Spec. Ins. De Geer 75 (1783)[3]. *Formica flavipes* Fourcroy Entom. Paris **2** 452 (1785)[4]. *Formica fusca* Fourcroy Entom. Paris **2** 453 (1785)[5]; Razoumowski Hist. Nat. Jorat. **1** 224 (1789)[6]. *Formica tristis* Christ Naturg. Ins. 513 (1791)[7]. *Formica nigra* Latreille Ess. Hist. Fourmis France 39 (1798)[8]. *Formica fusca* Latreille Hist. Nat. Fourmis 159–163 (1802)[9]. [" La fourmi noire-cendrée " Huber Mœurs Fourmis 43–51 (1810)[10].] *Formica fusca* Westwood Introd. Mod. Class. Ins. **2** Synops. 83 (1840)[11]; Nylander Acta. Soc. Sc. Fenn. **2** 919 (1846)[12]: **3** 27 (1849)[13]; Schenck Jahrb. Ver. Naturk. Nassau **8** 11[14] 43–45[15] (1852); Mayr Verh. Zool. Bot. Ver. Wien **5** 346–347 (1855)[16]; F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 104 (1855)[17]: Cat. Brit. Foss. Hym. 9 (1858)[18]; A. Müller Ent. Mo. Mag. **9** 120 (1872)[19]. *Formica fusca* r. *fusca* Forel Denkschr. Schweiz Ges. Naturw. **26** 54[20] 165[21] 217[22] 357[23] 399[24] 408[25] (1874). *Formica fusca* Forel Bull. Soc. Vaud. Sc. Nat. **14** 60 (1875)[26]; Saunders Trans. Ent. Soc. Lond. **1880** 207[27]; H. Müller Alpenblumen 591 (1881)[28]; Er. André Spec. Hym. Europe **2** 182 (1881)[29]; Lubbock Journ. Linn. Soc. Zool. **15** 384 (1881)[30]: Ants, Bees, Wasps 34[31] 38–39[32] 91[33] (1882): Journ. Linn. Soc. Zool. **20** 133 (1888)[34]; Dalla Torre Cat. Hym. **7** 196 (1893)[35]; Wasmann Biol. Centralb. **15** 617 (1895)[36]; Farren-White Ants' Ways 233–234 253 (1895)[37]; Saunders Hym.-Acul. 22 (1896)[38]; Malloch Ent. Mo. Mag. **40** 42 109 (1904)[39]; Dalglish Ent. Mo. Mag. **40** 87 (1904)[40]; Janet Obs. Fourmis 34–35 (1904)[41]; Wasmann Biol. Centralb. **25** 193 (1905)[42]; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 223 (1908)[43]; Wasmann Biol. Centralb. **29** 663 (1909)[44]: Arch. Trim. Inst. R. Grand Ducal Luxemburg **4** 75–81 (1909)[45]; Arnold Ent. Mo. Mag. **45** 278 (1909)[46]. *Formica fusca fusca* Emery Deutsch. Ent. Zeitschr. **1909** 196[47]. *Formica fusca* Silverlock Nat. **35** 13 (1910)[48]; Wheeler Ants 174[49] 654[50] (1910); Donisthorpe Trans. Ent. Soc. Lond. **1910** 144[51]: Ent. Rec. **23** 11 (1911)[52]: Entom. **44** 390 (1911)[53]: Ent. Rec. **24** 7 (1912)[54]: **25** 66[55] 268[56] (1913); Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 31–34 (1913)[57]. *Formica fusca fusca* Wheeler Bull. Mus. Compar. Zoöl. **53** 494 (1913)[58]. *Serviformica* (*Formica*) *fusca* Forel Ann. Soc. Ent. Belg. **57** 361 (1913)[59]. *Formica fusca* Donisthorpe Ent. Rec. **26** 41 (1914)[60]; Schmitz Jaar. Natuur. Genoots Limburg **1915** 15–27 [61]; Stainforth Nat. 1915 388–90[62]. *Formica* (*Serviformica*) *fusca fusca* Emery Bull. Soc. Ent. Italiana **47** 254 (1916)[63]. *Formica fusca* Johnson Irish Nat. **27** 3 (1918)[64]; Donisthorpe Ent. Rec. **31** 2[65] 25[66] (1919): **34** 3[67] 82[68]

(1922); Wheeler Psyche **29** 175 (1922)[69]. *Serviformica fusca* Lomnicki Bull. Ent. Pologne **3** 28 (1924)[70]. *Serviformica glebaria* Lomnicki Bull. Ent. Pologne **3** 31 (1924)[71]. *Formica* (*Serviformica*) *fusca* Emery Gen. Ins. **183** 247 (1925)[72].

Dalla Torre[35] queries *F. barbata* Razoumowski [Hist. Nat. Jorat. **1** 225 (1789)], and *F. capsincola* Schilling [Ubers. Arbeit. Schles. Ges. Vaterl. Kultur **1838** 54, (1839)] as synonyms of *F. fusca* L. The description of the former does not agree with *fusca*, and the latter as pointed out by Roger [Berlin Ent. Zeitschr. **1** 17 (1857)] more probably refers to *Acanthomyops niger* L.

☿ *Black, mandibles, scape, base of funiculus, tibiae, tarsi, and articulations of the femora reddish brown; femora blackish brown; hairs short and sparse, pubescence white, more abundant, especially on gaster; puncturation fine and close, being somewhat shagreened, especially on the gaster.*

Head longer than broad, narrowed anteriorly, not emarginate posteriorly; *clypeus* entire, somewhat pointed anteriorly, carinate for its whole length; *frontal area* dull; *eyes* large, bare; *mandibles* armed with eight teeth; *antennae* slender, *scape* slightly thicker at apex, *funiculus* slightly thickened towards apex with joints two and three slightly narrower but not longer than the rest. *Thorax* narrow, depressed above, not very convex; constriction between mesonotum and epinotum shallow; *epinotum* horizontal above and sloping at the base, both surfaces when seen in profile straight, and forming a distinct angle at their juncture. *Scale* rounded, *gaster* small. *Long.* 3·8–6·8 mm.

♀ *Black, somewhat shining; legs and antennae darker or lighter reddish brown. I possess a specimen from Scotland in which the mandibles, scapes, and legs are clear yellow. The colour and pubescence is much as in the worker.*

Head, without mandibles, about as broad as long, somewhat rugosely punctured, the sculpture being rough and close, but formed of distinct, close punctures, without small scattered punctures; *clypeus* entire, carinate; *frontal area* dull and punctured. *Thorax* broader than head, with very sparse hairs, somewhat pubescent; *mesonotum* distinctly punctured, especially anteriorly, alutaceous between the punctures, with some scattered larger, and small, punctures; *scutellum* nearly smooth in centre, punctured at sides, somewhat shining. *Scale* broader than in the ☿, rounded; *gaster* almost without hairs except the bristles on the margins of the segments, distinctly punctured and pubescent. *Wings* slightly yellowish, pterostigma brown. *Long.* 7–10·6 mm.

♂ *Black, scapes dark brown, tips of mandibles brownish yellow, legs and genitalia yellow, last joint of tarsi, and femora sometimes darker.*

Head narrowed anteriorly, broad posteriorly; *clypeus* entire, convex, carinate; *frontal area* dull, punctured. *Thorax* broader than the head, with very sparse, short black hairs; *mesonotum* dull, closely punctured. *Scale* not or only slightly and widely emarginate at apex, glabrous; *gaster* long, narrow, shining, very finely punctured, with short, close pubescence, but without outstanding hairs. *Wings* greyish, a little darker than in the ♀. *Long.* 7–8·5 mm.

Original description of *Formica fusca* Linnaeus [Syst. Nat. Ed. 10 **1** 580 (1758)] :—

"F. cinereo-fusca, tibiis pallidis.
Fn. suec. 1022, Formica fusca.
Raj. ins. 69. Formica media, nigro colore splendens.
Habitat in Europae *terra sabulosa.*"

Habitat.

Formica fusca is widely distributed through North and Central Eurasia; but in Southern Europe occurs only in mountainous country, and there often at considerable elevations [up to 2400 metres in the Alps (and 12,000 feet in Colorado)] according to Forel. This form is also widely distributed through Boreal America. Wheeler states that on careful examination he is unable to detect any important differences between the form which he described as the var. *glacialis* from Maine and the true European *fusca*. The wings of the males and females in the American form are perhaps slightly darker, but the tint is variable in European specimens. The sculpture, colour, and pubescence are identical in the two forms. The specimens from Newfoundland, including in all probability those from St. Pierre and Miquelon, Newfoundland, mentioned by Emery [Zool. Jahrb. Syst. 7 660 (1893)], and the specimens from Nova Scotia and New Brunswick agree very closely with the co-types from Maine. The western forms are often a little more like *subsericea* in pubescence and may be regarded as a transitional to that variety. Should it be possible on further study to detect any satisfactory differences between American and Eurasian specimens, the term *glacialis* would, of course, have to be reinstated[58].

Wheeler records that he was astonished to find among a fine collection of ants made for him by Dr. J. W. Chapman, on the Island of Negros Oriental, Philippines, a number of workers agreeing in all respects with European and North American specimens of the typical *F. fusca*. He suggests that it is probable that these Formicas reached Dumagnete (lat. 9° 30′ N.) from the United States in merchandise imported for the Silliman Institute[69].

In Britain *F. fusca* is very widely distributed, but does not, as far as I know, range higher than an elevation of 2000 feet—in 1910 I found it in numbers on Beinn-a-Bhuird, a mountain at Braemar over 4000 feet high, with perpetual snow on the top, but the *fusca* colonies which were under stones, appeared to cease below 2000 feet[52].

I have no records in England, from South Wilts, Herts, Hunts, Northampton, Monmouth, and Hereford; in Wales for Cardigan, Montgomery, and Carnarvon; and in Scotland, Selkirk, Roxburgh, North Aberdeen, Banff, North Ebudes, West Sutherland, Caithness, the Hebrides, the Orkneys, and the Shetlands. In Ireland I have records only from Antrim, Down, Armagh, Tyrone, Donegal, Fermanagh, Louth, Dublin, Kildare, Wicklow, Wexford, Carlow, Westmeath, West Mayo, Clare, North Tipperary, South Cork, and Kerry.

Formica fusca, which according to Wheeler is indistinguishable by any satisfactory characters from the *F. flori* Mayr of the Baltic amber[49], is an abundant and widely distributed species, nesting

in woods, meadows, and uncultivated places, but also occurs in gardens, under the steps and foundations of houses, in walls, etc. It prefers damp and shady places, but can also live in sunny and dry spots, and its nests are situated under stones and logs, in rotten tree stumps, and fallen branches, in banks and at the roots of herbage, etc. Morton found it nesting in sphagnum, in Staffordshire, and Phillips under the same circumstances in East Galway. I have found it occupying the deserted nests of *F. rufa* and *F. exsecta*[60], but it never, of its own accord, heaps any vegetable refuse over its nests, though it sometimes constructs an earthen mound. Its methods of building its chambers and galleries are not so elaborate nor so perfect as those of *Acanthomyops niger*; Huber describes the architecture of *fusca*[10], but, as Forel has pointed out, this is not as regular nor as complete as stated by the former author[21].

The colonies of *fusca* are usually only of medium size, and often very small; very large ones being of rare occurrence.

In September, 1911, I observed a very small race of *fusca*, the nest of which was situated under a stone on the Isle of Eigg[54]; the ground beneath being too stony to allow the nest to be properly dug up, no female was found, but all the workers were exceedingly small, measuring little over 4 mm. in length.

F. fusca is a shy and cowardly ant, fleeing before danger, and as it is abundant, it naturally lends itself to exploitation by other species. It is very agile and rapid in its movements, but possesses no tactics, not knowing how to effect a combined defence of its nests, and though the hidden entrances of the latter enable it to live close to and in the neighbourhood of other species, it is always liable to be raided by them. The workers do not forage together in troops, but go out singly hunting insects, attending *Aphidae* on bushes, etc., and visiting flowers—they may frequently be seen in the flowers of umbelliferae, and H. Müller records thirty-eight visits of *fusca* workers to different flowers, twenty-four to alpine plants alone[28].

Dr. Chapman observed workers of *F. fusca* attending beetles (*Larinus onopordi*) on thistles at Gavarnie on July 29th, 1914, four or five ants being at work on a single beetle; they were not attacking the insect, and it would seem they were obtaining a secretion of some sort from it.

The workers may be seen returning to their nests, bringing in flies, remains of beetles and other insects, and they will attack the males and females of *Acanthomyops niger* and *flavus*, etc., after the marriage-flight, and carry them off as food.

Lubbock writes of the hunting habits of this ant as follows :—

"Some species, such as *Formica fusca*, live principally on the produce of the chase; for though they feed partly on the honey-dew of aphides, they have not domesticated these insects. These

ants probably retain the habits once common to all ants. They resemble the lower races of men, who subsist mainly by hunting. Like them they frequent woods and wilds, live in comparatively small communities, and the instincts of collective action are but little developed among them. They hunt singly, and their battles are single combats, like those of the Homeric heroes "[33].

It is not, however, correct to say that *F. fusca* has not domesticated aphides, as although Forel stated that the ants of the genus *Formica* never rear plant-lice in their nests, but only seek them on plants, on September 9th, 1874, he observed at Andermatt a number of large yellow root *Aphidae* in a nest of *F. fusca* under a stone, and he saw the ants carry them into safety. He remarks that this is the only time he had seen these insects in a *fusca* nest, but he must modify his former statement[26]. I have frequently found aphides in *fusca* nests, comprising some six species, and on October 25th, 1908, I captured a *fusca* worker at Luccombe Chine, which was carrying an aphis in its jaws home to the nest situated in the side of the cliff.

Lubbock kept individual specimens of this ant alive for considerable periods; he possessed workers which were at least seven years old, and two queens which were much older. He says :—

" One of these queens, after ailing for some days, died on the 30th July, 1887. She must then have been more than 13 years old. I was at first afraid that the other one might be affected by the death of her companion. She lived, however, until the 8th August, 1888, when she must have been nearly 15 years old, and is therefore by far the oldest insect on record "[34].

He also had, in 1880, five queens developed in one of his *fusca* nests, and as the nest had been under observation since April, 1879, the eggs must have been laid in captivity. He suggests that, as the nest had been richly supplied with animal food, this may possibly account for the fact, and that ants possess the power of developing a given egg into either a queen or a worker[30].

Microgynes are often abundant in colonies of this species; Wasmann records such females in *fusca* nests at Exaeten in August, 1890[36], and subsequently in plenty at Luxemburg[45]; Arnold found winged microgynes in three nests of *fusca* in the New Forest in July, 1909; he says no normal females occurred, but normal males were present in two of the nests[46]; and Mitford gave me a very small deälated microgyne, which he had taken in a colony of *fusca* at Rothes, in Morayshire, in 1912, this specimen being no larger than a medium-sized worker[55].

I found these small females in abundance in *fusca* nests at Tenby in April, 1913[60], all being deälated and in company with normal deälated queens, and again on Lundy Island in June of the same year, some specimens being winged and others with wing

stumps[56]. Janson captured a *fusca* microgyne at Howth, Co. Dublin, in July, 1919.

Wasmann describes a number of forms of *F. fusca* pseudogynes from Holland and Luxemburg[44], but I do not know of a single pseudogyne of *fusca* ever having been found in Britain.

Stellfox took a deformed male of this species at Cratloe, Co. Clare, in 1895, which he kindly presented to me. The left antenna is deformed; the scape being shorter than that of the right one, which is of normal length, and the joints of the funiculus are soldered together into a sort of spiked club. Although most of the joints of the funiculus are so mixed up, yet it is almost possible to recognize twelve, which is the normal number of joints (not counting the scape, which makes it thirteen) in the male of *Formica*. This ant is otherwise quite normal; excepting that the mandibles possess four or five well-developed teeth. This latter character has nothing to do with the deformity of the antenna; as I have seen a number of other *fusca* males (taken in Ireland by Phillips) with toothed mandibles, which are in every respect normal and perfect[68].

[This struck me as being remarkable as, though I have examined hundreds of male specimens of *F. fusca*, I had never seen a specimen with toothed mandibles before; moreover, in the following works, both in the tables and under the descriptions of the species, the male of *F. fusca* is stated to possess mandibles without teeth—André Spec. Hym. Europe (1881); Donisthorpe 1st Edtn. British Ants (1915); Emery Palaearktische Formiciden (1909): Formicidae Italianae (1916); Forel "Fourmis de la Suisse" (1874). Nevertheless Wheeler in his "Revision of the Ants of the Genus *Formica*" [Bull. Mus. Compar. Zool. **53** 495 (1913)], when describing the male of *F. fusca* L., states that the mandibles are "often, if not always, denticulate"; so the fact was evidently well known to him[68].]

Forel has found the males and winged females in the nests in Switzerland in June, July, and August[25], and I have found them in the nests in Britain in the same three months, and also in September; sometimes they occur together, sometimes only one sex will be present in a nest.

Malloch records finding a winged female in a *fusca* nest in April[39], Dalglish says he has seen them in March[40], Butterfield a male at Keighley, N.E. Yorks, on March 20th, 1919, and Crawley and I observed twelve winged females in a *fusca* nest at Porlock on April 27th, 1911, but these are only cases where they have passed the winter in the nest, not having left for the marriage-flight the year before.

Schenck says this species swarms in July and the beginning of August[15], Mayr midsummer[16], and André the middle to the end of the summer[29]. A. Müller records that at 8.50 in the morning of August 18th, 1872, he captured a female *F. fusca* which was flying across the road, at South Norwood, with a drooping flight, and he

found that she was in simultaneous copulation with two males aside of each other[19].

It appears to me more probable that the species Müller caught was really *Acanthomyops niger*; it is doubtful whether any of the females of *Formica* carry the males, which are as large as the females, during the marriage-flight, and it seems impossible that a female could fly, carrying two specimens at once. The early morning is certainly not the time for the marriage-flight of *A. niger*, but as the males were so fixed in the female that *gentle* pulling was not enough to sever them, they might well have remained in this condition since the evening before.

There does not appear to be any other record of the actual copulation of *F. fusca*, supposed, or otherwise.

I captured a female *fusca* on the wing at Oxshott on July 7th, 1912[55], and found a winged female and several freshly deälated ones running on paths at Weybridge on July 29th, 1913—a marriage-flight having probably taken place that day—and a male flying near Lake, Isle of Wight, on August 26th, 1913; but on the afternoon of May 22nd, 1921, when at Bewdley, I captured a female of this ant on the wing. This appears to be the earliest date on which a winged *fusca* female has been found away from the nest[67].

In the late Rev. O. Pickard-Cambridge's collection I found three winged females and two males mounted on one card and labelled "Blox., Poole Rd., Aug. 9th, 1915." These were most probably captured during a marriage-flight[65]. Johnson records workers and winged females on the Sandhills at Portnow, Co. Donegal, in September, 1917[64].

On July 25th, 1918, I observed a colony of this species situated in a cavity at the foot of one of the posts supporting the porch at Ramnor Lodge in the New Forest. At 12.30 winged females were observed to emerge from the entrance to the galleries and after running all about the porch to re-enter the nest. Though none were actually seen to take to the wing, they were evidently preparing for the marriage-flight, which no doubt took place later in the day, as at 2.30 a male was captured flying in the sand-pit near Matley Passage[66].

Wasmann suggests that the marriage-flight takes place near the nest[45], which would account for the number of deälated females often found in one nest, most of them having been received back into their own community, for, as we shall see presently, *fusca* colonies receive a strange *fusca* female with the greatest animosity.

Silverlock records finding eighteen deälated females in a *fusca* nest under a large stone near Halifax[48], and I have frequently found many queens in a single *fusca* nest—in the County Meath, at Tenby, and on Lundy, etc.

It is a curious fact that *fusca* nests which contain a number of females are not as a rule more populous than those which possess only one.

The eggs are first laid in April, and worker pupae occur in nests up to the beginning of the winter.

Eggs laid by workers in queenless nests have, according to Lubbock[32] and others, only produced males.

The pupae of this species are enclosed in cocoons, but naked pupae also occur—Schenck records finding them at Nassau[14], I found naked female pupae in a *fusca* nest at Weybridge on July 18th, 1912[55], naked worker pupae in numbers at Box Hill on July 30th, 1913, and also in Parkhurst Forest on August 23rd, 1913, in a nest under a fallen branch[60].

The workers carry out the empty cocoons, after the ants have emerged from them, and scatter them outside the nest.

The females of the *F. fusca* group undoubtedly found their colonies unaided, incipient colonies having been observed in nature, and have also been brought up in captivity. As has been already stated, a *fusca* female will not be received into a strange *fusca* colony, the workers always attacking and killing her.

Forel says he has often seen fertile *fusca* females running in the neighbourhood of a strange nest of her own species, and when she has encountered workers of the latter they have at once killed her[24]; Lubbock records cases in which fertile females, introduced into queenless nests, were ruthlessly attacked[31]; Crawley made several experiments with *fusca* queens and colonies of *fusca*, both with and without queens, in all of which the strange females were attacked[57], and I have frequently endeavoured to introduce *fusca* females into observation-nests containing strange colonies of their own species, but these queens have always been killed.

There are, however, a few cases on record in which *fusca* females have been accepted by strange races in observation-nests.

On June 1st, 1909, I introduced some workers of *Formica fusca* var. *glebaria* taken in April at Whitsand Bay into a small glass bowl, which contained sand, and a deälated female *F. fusca* taken at Bradgate Park in May—the female had laid a few eggs in a small chamber underneath a piece of damp sponge. On June 27th the rest of the *glebaria* workers taken at Whitsand Bay were introduced, the queen was not attacked, and on July 4th all the workers had collected under the sponge with her[51].

In October, 1909, Crawley introduced a number of *F. subsericea* workers obtained in the United States to a female *F. fusca* from England, and all were friendly with the queen. In 1912 the colony was still in existence, and a few *subsericea* workers were still alive, though a large number of *fusca* workers were present reared from eggs laid by the queen[57].

It seems unlikely, however, that in nature a colony of *fusca*, or

its races, would be founded in any other way than by the normal, viz. by one or more queens without workers.

On June 25th, 1906, Wasmann found at Shötter Marial two young *fusca* colonies under stones, the one containing a queen, with six small workers, and a dozen worker larvae and pupae, and the other two queens, six small workers, and a dozen half-grown larvae[44]. In the latter case two young queens must have joined together to bring up their family. For some years past I have experienced considerable difficulty in finding a single nest of *F. fusca* at Weybridge, which I attributed to the fact that *F. sanguinea* had spread over the district and by continual raids had nearly exterminated the *fusca* colonies, but in June, 1914, I found a number of small colonies, under gorse roots and at the foot of fir stumps, etc., many of them being incipient colonies containing only a few small workers and brood. A number of males and females must have been reared in some isolated nest, or nests, and a fair proportion of the females, after the marriage-flight, had successfully founded new colonies.

In the following cases broods have been brought up by females from their eggs laid in captivity.

Wasmann, in April, 1886, found a fertile female *fusca* running about at Exaeten, and placed her in a small glass with some damp earth and food. He did not look at it again till June 14th, when he saw the female resting in a small hole in the earth, with six worker cocoons and two full-grown larvae[12].

Janet, in 1904, placed a *fusca* female, which had got rid of her wings on July 8th, in an observation-nest, and in a few days a fairly large packet of eggs was laid, which soon hatched. On July 28th the first larva spun its cocoon, and on August 22nd the first callow made its appearance[41].

On September 14th, 1910, I took five *fusca* females from a colony, nesting under the bark of a tree stump in a bog at Balrath, Co. Meath, which contained very many females. On September 17th, when I reached home, they were placed in a plaster nest, where they all laid eggs, which they carried about, but which all eventually disappeared. Three of these females were taken away for other experiments, and the remaining two lived together all through 1911. January 31st, 1912, one of them laid a few eggs, which she held in her mandibles—February 6th both females holding bunches of eggs: they were quite friendly and sometimes one alone carried all the eggs—February 27th eight larvae present, three of which pupated on March 2nd, the number increasing to seven by the 11th—March 24th a fresh batch of eggs laid—April 1st the first *fusca* callow hatched, carried about by one of the females—April 3rd a second callow appeared—April 4th another present, but it was dead—April 8th a third callow hatched, assisted by the other two—April 7th more eggs had been laid, carried about by

the tiny workers—May 14th small bunch of larvae present carried by the workers—May 19th a fourth callow present. By June 6th one of the females had a swollen gaster, but the other, which had been ailing for some time and was of normal size, was dragged by an antenna by one of the workers, and as ants do not drag another by the antennae when their motives are friendly, this would seem to be a hostile act: at any rate this female was dead on June 7th, and put in the outside chamber[57]. The female with the swollen gaster and the four little workers lived together for some time, more eggs were laid, but no further brood was reared. One of the four workers died on November 26th, 1912, two more on January 27th, 1913, and the fourth on February 4th, 1913, the queen dying on March 4th, 1913.

On April 25th, 1913, I brought home a number of *fusca* females taken in nests at Tenby, June 9th microgynes from Lundy, and July 29th some *rufibarbis* queens taken in a nest at Weybridge, all of which were placed in a small plaster nest. January 1st, 1914, one *fusca* female, one microgyne, and one *rufibarbis* female were introduced into a small "Crawley-Lubbock" earth nest—April 2nd eggs present, each female carrying them about in turn—May 1st small larvae present, carried equally by the large *fusca*, and the *rufibarbis* females (from this time forward the microgyne paid no further attention to the brood)—May 25th two cocoons and seven larvae present—June 1st all larvae in cocoons—June 8th the *rufibarbis* queen with a small packet of eggs in her jaws, only five cocoons and one empty case, but no worker, present—June 21st only four cocoons and a bunch of eggs present, the empty cocoons being buried in a small hole dug in the earth and filled up again—July 1st three small *fusca* callows hatched—July 4th a fourth callow present, four small larvae and three larger ones—July 10th four of the larvae in cocoons, only one other larva present—July 15th the *rufibarbis* female had her head bitten off. This would seem to show that *fusca* and *rufibarbis* females will not found colonies together, and in this instance the latter's brood was not allowed to develop.

The under-mentioned species of myrmecophiles have been taken with *Formica fusca* in Britain :—

Coleoptera : *Homoeusa acuminata* Märk., *Aleochara ruficornis* Gr., *Atemeles emarginatus* Pk., *Myrmedonia limbata* Pk., *Drusilla canaliculata* F., *Lamprinus saginatus* Gr., *Neuraphes carinatus* Muls., *Batrisodes venustus* Reich., *Trichonyx märkeli* Aub., and *Hetaerius ferrugineus* Ol.

Formicidae : *Ponera coarctata* Latr., *Myrmecina graminicola* Latr., *Stenamma westwoodi* West., and *Leptothorax acervorum* F.

Braconidae : *Spilomma falconivibrans* Morley, *Chasmodon apterum* Nees, and *Aspilota concolor* Nees.

Proctotrupidae : *Antaeon brevifilis* K., *Gonatopus striatus* K.,

Lagynodes pallidus Boh., *Plesiobœus hospes* K., *Synopeas fuscicola* Box., *Trichopria formicaria* K., and *Embolemus ruddi* West.

Cynipidae : *Rhoptromeris formicaria* K.

Diptera : *Microdon mutabilis* L. (larvae and pupae), *Platyphora lubbocki* Verrall, *Aenigmatias blattoides* Mein. var. *highlandica* Schm., *Limosina rufilabris* Stnh., *Ceratopogon braueri* Wasm., *Drapetis nervosa* Lw., and *Peyerimhoffia subterranea* Schm.

Heteroptera : *Alydus calcaratus* L., *Nabis lativentris* Boh., *Pilophorus perplexus* D. and S., *Systellonotus triguttatus* L., and *Ceratocombus coleopteratus* Zett.

Aphidae : *Trama radicis* Kalt., *Forda formicaria* Heyd., *Pentaphis marginata* Koch., *Lachnus nudus* Retz., *Brysocrypta ranunculi* Kalt., *Tetraneura uhlmi* Geoff., and *Schizoneura corni* F.

Coccidae : *Ripersia tomlini* Newst., *R. europaea* Newst., and *Newsteadia floccosa* West.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic., and *Smynthurus caecus* Tull.

Myriapoda : *Polyxenus lagurus* L.

Araneina : *Thyreosthenius biovata* Camb., *Evansia merens* Camb., *Cryphoeca recisa* Camb., *Phrurolithus minimus* C.K., *Harpactes hombergi* Scp., *Micaria scintillus* Camb., and *M. pulicaria* Sund.

Pseudoscorpionina : *Ideoroncus cambridgii* L. Koch.

Acarina : *Discopoma pulcherrima* Berl., *Uroobovella notabilis* Berl., *U. obovata* C. and B., *Trachyuropoda coccinea* Mich., *T. coccinea* var. *sinuata* Berl., *T. laminosa* C. and B., *Laelaps* (*Hypoaspis*) *myrmecophilus* Berl., *L.* (H.) *myrmophylus* Mich., *L.* (*Oolaelaps*) *oophilus* Wasm., *L.* (*Cosmolaelaps*) *cuneifer* Mich., *L.* (O) *montanus* Berl., *Tryoglyphus wasmanni* Mon., and *Urodinychus janeti* Berl.

Crustacea : *Armadillum pulchellum* Brdt., and *Platyarthrus hoffmanseggi* Brdt.

Of the forms of the *Formica fusea* group in which the workers are *not* black, and the males and females are *not* shining, but dull or opaque, it is impossible to say what is actually intended by the older British records, the name *F. cunicularia* Latr. being used loosely for various forms, and not restricted to the species which is now known as *rufibarbis* F. (=*cunicularia* Latr.).

Most of the British references to *cunicularia* really mean (wholly, or in part) one, or both, of the vars. of *fusca.*

In 1880 Saunders mentions only *cunicularia* and *fusca* (Trans. Ent. Soc. Lond. **1880** 206) ; his description of the former agrees with *rufibarbis*, but he states it is "generally distributed and common in many localities," which is not the case with *rufibarbis* in Britain.

In 1896 he gives "race *rufibarbis* Fab.=*cunicularia* Latr.," and says *rufibarbis* is more local than *fusca*, but is widely distributed [Hym -Acul. 22 (1896)].

Saunders's records must include *rufibarbis*, *fusca* v. *glebaria*, and *fusca* v. *rubescens*, and most of the older records doubtless refer to one of these vars. rather than to *rufibarbis*.

It should perhaps be mentioned that specimens of *glebaria* taken at Weymouth in 1896, and of *rubescens* taken in the New Forest the same year, were *both* determined for me by Saunders as *cunicularia*.

In 1906 I introduced *F. rufibarbis* v. *fusco-rufibarbis*—teste Wasmann (=*F. fusca* v. *fusco-rufibarbis* Donis. nec Forel) as British [Ent. Rec. **18** 217 (1906)], and in 1911 Crawley brought forward *F. fusca* v. *glebaria* Nyl. [Ent. Rec. **23** 96 (1911)], but I now believe the insects in question are both *glebaria*; certainly I am unable to distinguish them. In 1909 I introduced *F. fusca* v. *rubescens* Forel as British [Ent. Rec. **21** 258 (1909)], and in 1911 pointed out that the varieties of *Formica fusca* have been quite inaccurately determined in this country—endeavouring to distinguish *rubescens*, *glebaria*, and *fusco-rufibarbis* by differences in the pubescence and their habitats [Entom. **44** 391 (1911)].

Subsequent researches, however, have shown that no reliance can be placed on the situations in which these ants occur [Ent. Rec. **25** 66 (1913)], and degrees of pubescence are of little value.

Forel when describing var. *rubescens* [Ann. Soc. Ent. Belg. **48** 423-424 (1904)] says it is the var. " à thorax rougeâtre " in his Fourmis de la Suisse—this is *F. fusca* v. *fusco-rufibarbis*—and he points out that the var. *rubescens* has been frequently mistaken for *F. rufibarbis* F.

Emery in his paper on the Palaearctic species of *Formica* [Deutsch. Ent. Zeitschr. **1909** 179–204] makes no mention of the var. *fusco-rufibarbis*, and neither does Wheeler in his monograph of the genus *Formica* [Bull. Mus. Comp. Zoöl. **53** 379–565 (1913)].

Recently I sent to Wheeler a large number of specimens, males, females, and workers, of what I had endeavoured to separate into *rubescens*, *glebaria*, and *fusco-rufibarbis*, and he was only able to detect *rubescens* and *glebaria* among them, and in these determinations I entirely concur.

Wasmann considers *fusco-rufibarbis* to be a variety of *rufibarbis* F., mainly because the beetles *Atemeles paradoxus* and *Dinarda pygmaea* are found with these two ants, and not with *fusca*; but having received from me specimens of what is called *glebaria* by Emery, Wheeler, and myself, he tells me this is his *fusco-rufibarbis*, and says—" Between these two forms (*glebaria* and *rubescens*) and the true *rufibarbis*, there are so many transitions, that it is hard to make them varieties of *fusca* instead of *rufibarbis*."

The smaller workers of *glebaria* and *rubescens* are almost indistinguishable, and even of *rufibarbis* the small dark workers cannot be distinguished by their colour alone ; this species can, however,

always be recognized by the outstanding yellow hairs on the thorax—these are not present in *fusca* or its varieties. It may be stated emphatically that it is useless to take odd specimens of these varieties and expect to name them with any certainty. If, however, a number of specimens be taken, the habits of the ants and the nature of their nest noted, all sexes of the form (supposing that to be possible) collected, and the individuals from different nests not mixed, they can be accurately determined.

Under the Habitat of these forms I only give such British localities as I am personally acquainted with or from which I have actually seen specimens, as no good purpose could be served by reprinting dubious records of ants under the names of "*cunicularia*," etc.

Formica fusca L., var. glebaria Nyl.

Formica glebaria Nylander Acta. Soc. Sc. Fenn. 2 917–919: Pf. **18**·14 (1846)[1]; Förster Hym. Stud. **1** 31–32 (1850)[2]. *Formica cunicularia* F. Smith Zool. 9 3249 (1851)[3]: Trans. Ent. Soc. Lond. (n.s.) 3 102–104 (1855)[4] [in part?]: Cat. Brit. Foss. Hym. 8 (1858)[5] [in part ?]: Ent. Mo. Mag. 2 29 (1865)[6] [in part ?]: Ent. Ann. **1870** 28[7]: **1872** 95[8]: Ent. Mo. Mag. **11** 111 (1874)[9]. *Formica fusca* "des prés" Forel Denkschr. Schweiz Ges. Naturw. **26** 54 (1874)[10]. [*Formica cunicularia* Cooke Nat. 5 73 (1879)[11] ?]; [Service Scot. Nat. 5 63 (1879)[12] ?] [Parfitt Trans. Devon Assn. Sc.-Lit. **12** 513 (1880)[13] ?]; Fowler Ent. Mo. Mag. 21 37 (1884)[14]; Farren-White Ants' Ways 233 (1895)[15] [in part]. *Formica rufibarbis* Saunders Hym.-Acul. 22 (1896)[16] [in part] [*Formica fusca* race *cunicularia* Cuthbert Irish Nat. **6** 324 (1897)[17]: 7 67 (1898)[18] ?]; Vic. Hist. Hants **1** 115 (1900)[19] [in part ?]; [Vic. Hist. Essex **1** 98 (1903)[20] ?]; [Vic. Hist. Sussex **1** 131 (1905)[21] ?]; Vic. Hist. Devonshire **1** 187 (1906)[22]; [Vic. Hist. Berks **1** 76 (1906)[23] ?]. *Formica rufibarbis* var. *fusco-rufibarbis* (*teste* Wasmann) Donisthorpe Ent. Rec. **18** 217 (1906)[24]. [*Formica fusca* race *rufibarbis* Vic. Hist. Yorks **1** 216 (1907)[25] ?]. *Formica fusca* race *cunicularia* Vic. Hist. Kent **1** 116 (1908)[26] [in part]. *Formica rufibarbis* var. *fusco-rufibarbis* Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 223–224 (1908)[27]: Ent. Rec. **20** 281 (1908)[28]: 21 287 (1909)[29]. *Formica fusca fusca* var. *glebaria* Emery Deutsch. Ent. Zeitschr. **1909** 196–198[30]. *Formica rufibarbis* var. *fusco-rufibarbis* Donisthorpe Trans. Ent. Soc. Lond. **1910** 145[31]. *Formica fusca glebaria* Emery Deutsch. Ent. Nat. Bibliot. 2 4–5 (1911)[32]. *Formica rufibarbis* var. *fusco-rufibarbis* Donisthorpe Ent. Rec. 23 62 (1911)[33]. *Formica fusca* var. *glebaria* Crawley Ent. Rec. **23** 96 (1911)[34]; Donisthorpe Entom. **44** 390–391 (1911)[35]. *Formica fusca* var. *fusco-rufibarbis* Donisthorpe Entom. 44 390–391 (1911)[36]. *Formica fusca fusca* subsp. *glebaria* Emery Deutsch. Ent. Zeitschr. **1912** 672[37]. *Formica fusca* var. *fusco-rufibarbis* Donisthorpe Ent. Rec. **24** 7 (1912)[38]: **25** 66 269 (1913)[39]. *Formica fusca* var. *glebaria* Donisthorpe Ent. Rec. **25** 66 (1913)[40]; Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 32 (1913)[41]. *Formica fusca* var. *fusco-rufibarbis* Crawley and Donisthorpe Int. Ent. Cong. Oxford 1912 **2** 32 (1913)[42]. *Formica fusca fusca* var. *glebaria* Wheeler Bull. Mus. Compar. Zoöl. **53** 497 (1913)[43]. *Formica fusca* var. *fusco-rufibarbis* Donisthorpe Ent. Rec. **26** 41 (1914)[44]. *Formica fusca* var. *glebaria* Hallett Trans. Cardiff Nat. Soc. **47** 3 (1915)[45]; Crawley Proc. Somerset Arch. NH. Soc. **62** 154 (1916)[46]. *Formica* (*Serviformica*) *fusca glebaria* Emery Bull. Soc. Ent. Italiana **47** 254 (1916)[47]. *Formica fusca* var. *glebaria* Donisthorpe Ent. Rec. **31** 2[48] 25[49] (1919). *Formica fusca glebaria* Emery R. Accad. Sci. Istit. Bologna 1922 23–38 (1923)[50]. *Serviformica fusca* Lomnicki [in part] Bull. Ent. Pologne **3** 28–31 (1924)[51]. *Formica* (*Serviformica*) *fusca* subsp. *glebaria* Emery Gen. Ins. **183** 247 (1925)[52].

Schenck [Jahrb. Ver. Naturk. Nassau 8 43 (1852)] and Dalla Torre [Cat. Hym. 7 197 (1893)] incorrectly cite *Formica glebaria* Nyl. as a synonym of *F. fusca* L.; as also, more recently, does Lomnicki[51].

☿ *Blackish brown, with cheeks anteriorly, mandibles, scapes, base of funiculi, sutures of thorax, base of scale and legs brownish red.*

In size and structure like *fusca*, but besides not being black like the latter, the pubescence is longer and closer, especially on the gaster, which gives the insect a silky appearance. *Thorax* without outstanding hairs. *Long.* 4·5–7·5 mm.

♀ *Brownish black, darker than the* ☿, *cheeks anteriorly, mandibles, scapes, base of funiculi, thorax at the insertion of the wings, and legs reddish yellow, or reddish brown; scale lighter or darker brown.*

It differs from *fusca* in colour and in being more pubescent, the whole insect having a more or less silky appearance; *epinotum* entirely, or nearly entirely, dark. *Gaster* opaque, much more pubescent than in *fusca*. *Wings* slightly infuscate. *Long.* 8–9·5 mm.

♂ *Black, like* fusca, *but duller and more pubescent, especially on the gaster, and the legs are more reddish.*

Scale slightly, at any rate not deeply, emarginate. *Wings* a little darker than in the ♀. *Long.* 7·3–10·3 mm.

Original description of *Formica glebaria* Nylander [Acta. Soc. Sc. Fenn. 2 917–919 (1846)]:—

"*Operaria:* nigra nitida valde cinereo-micans; mandibulis, antennarum scapis flagellorumque basibus et pedibus vel totis vel tibiis tarsisque piceis seu piceo-rufescentibus; ocellis parvis; squama sursum late subtriangulariter subrotundata.

☿ Long. circa 2 lin. adeo similis praecedenti, ut omnia, quae de ea dicta sunt, in praesentem etiam speciem valeant, si addis tantum praecedenti nitorem cinereo-sericeam et demis ab abdomine ejusdem pilositatem longiusculam albidam. Palpi labiales articulo 3: tio subtriangulari apice latiusculo. Color ut supra. Abdomen dense cinereo-sericeum, setulis brevibus flavidis parcis, marginibus segmentorum saepe membranaceo-pallescentibus, basibus saepe quoque politioribus.

Femina: nigra nitida valde cinereo-micans; mandibulis, antennarum scapis, coxarum apicibus, trochanteribus, geniculis tibiisque cum tarsis piceo-rufescentibus; alis albo-hyalinis parum fuscedine tinctis, nervis fuscis, stigmate obscure fusco; squama late subtriangulari supra inaequali.

♀ Long. 3 lin. coloratus ut supra dictum. Caput quasi in ☿ formatum. Clypei carinula media sat distincta, parum infra aream frontis triangularem linea transversali abrupta; marginibus clypei externis buccalibus politis. Laminae frontalis margines ad radices antennarum parum sursum flexis. Thorax solitae in hac subdivisione structurae. Alae albo-hyalinae parum fuscedine tinctae, radice et tegula fuscis; alae anticae 3 lin. longae. Pedes fusco-nigri, trochanteribus, tarsis et articulationibus rufis, tibiis rufescentibus, tarsorum articulo ultimo fusco. Squama lata abdominis fere altitudine, sursum paullo latior quam infra, supra margine inaequali. Abdomen thoracis longitudine nitidissimum, totum pubescentia cinereo-micante subtili densa aequaliter vestitum, supra visum rotundato-ovale, pilis flavidis raris sparsis in ventre anoque pluribus; marginibus segmentorum conspicuius quam in ☿ obscure membranaceo-pallescentibus."

Habitat.

Formica fusca var. *glebaria* is widely distributed in North, Central, and Southern Europe, also in Asia, and has been introduced into gardens in Algiers[43]. Emery states that it does not occur in the smaller southern islands in the Mediterranean, and that it is absent from Crete[30], but Wheeler points out that Krausse has recently taken it in Sardinia[43].

British distribution :—

Cornwall, E. : Whitsand Bay[27], Rame Head[27], and Tregantle[27] (*Keys*) ; St. Issey (*Crawley* and *Donisthorpe*)[38] ; Trebetherick (*Hallett*).

Devon, S. : Plymouth and Meavy Valley (*Keys*) ; Seaton (*Crawley*). **Devon, N. :** Lundy Island (*Donisthorpe*)[39].

Somerset, S. : Porlock (*Crawley*).

Dorset : Weymouth (*Donisthorpe*) ; Swanage (*Nevinson*) ; Portland (*Haines*) ; Bloxworth (*O. P.-Cambridge*).

Isle of Wight : Chale, Blackgang[39], Sandown[28], and Landslip (*Donisthorpe*) ; Ventnor and St. Helens (*Saunders's Coll.*).

Hants, S. : Bournemouth and Hayling Island (*Saunders's Coll.*) ; New Forest (*Crawley*)[34].

Sussex, E. : Hastings (*Saunders's Coll.*).

Kent, E. : Folkestone (*Donisthorpe*). **Kent, W. :** Gravesend (*Donisthorpe*).

Middlesex : Hampstead (*Brit. Mus. Coll.*).

Essex, N. : Colchester (*Piffard*) ; St. Osyth (*Harwood*).

Oxford : Enslow Bridge (*Collins*).

Gloucester, W. : Stroud (*W. B. Davis*).

Monmouth : Trelleck (*Hallett*).

Glamorgan : Sully, Horton, Gower, and Porteynon Bay (*Hallett*).

Pembroke : St. David's (*T. W. Allen*).

Carnarvon : Abersoch (*Nevinson*).

Yorks, S.W. : Bradford (*Butterfield*).

Aberdeen, S. : Braemar (*Donisthorpe*).

Formica fusca v. *glebaria* occurs in fields, on cliffs, etc., on the Continent it lives in meadows and gardens, and Förster says it is often to be found on the borders of woods.

It nests under stones, in the sides of cliffs, etc., and frequently constructs earth-mounds, which in fields are covered with grass.

This variety is abundant at Whitsand Bay, nesting under large stones all along the slopes by the sea ; in the New Forest its nests consist of earth-mounds in open places, by the sides of enclosures, and also among scattered trees ; and in the Isle of Wight I have found it under stones, in the sides of cliffs, and in small earth-mounds. In 1918 very many nests were found in the New Forest

in July. One very interesting colony was inhabiting a large sphagnum mound in Matley Bog, the galleries of the nest leading right down through the sphagnum to chambers in the very wet earth beneath. A small colony had established its nests by the side of a path through Denny Bog, the mound over the nest being covered with tiny pebbles from the path. Several large colonies were dwelling in large mounds by the side of the railway at Beaulieu Road; these mounds being covered with little bits of cinders (picked up by the worker ants on the line) which gave them a curious black appearance[49].

The habits of *glebaria* are similar to those of *fusca*, but it is not quite so cowardly.

Emery considers *glebaria* to be a subspecies of *fusca*, because the latter will not readily bring up the pupae of the former, and when nearly mature, treat them with hostility[37].

Wheeler is not prepared to accept it as a subspecies[43], and I do not consider the treatment of the pupae in captivity to be a sufficient test in this matter; Forel had a nest of *Leptothorax tuberoaffinis* which brought up two workers of *Tetramorium caespitum* from pupae he gave to the former (*Fourmis Suisse* 340), and I gave some eggs of *Formica rufa* to workers of *F. fusca* and *F. glebaria*, and they reared some of them to pupae (these eggs were taken in a nest of *F. rufa* at Bexhill, and the *fusca* and *glebaria* workers were slaves from my former *sanguinea* nest), but these occurrences do not make the *Leptothorax* and *Tetramorium*, or the *F. rufa* and *F. fusca* forms, more nearly related.

The colonies of *glebaria* at Whitsand Bay appear to belong to a common stock; at any rate Keys found that females and workers from different colonies in that locality agreed perfectly well together, and on July 14th, 1909, he sent me several different lots with pupae, which voluntarily mingled and formed a single colony[31].

As with *fusca*, the pupae of *glebaria* are often naked; Keys found such pupae at Whitsand Bay in 1908, and I have found them in nests which also contained pupae in cocoons at Sandown, Isle of Wight, in 1908, on August 13th, 1913, and again in the "cinder" nests mentioned above on July 22nd, 1918[49].

I have found males and winged females in *glebaria* nests in July and August.

The females of *glebaria*, of course, found their colonies unaided; I found a small incipient colony consisting of a queen and about twelve workers, some of them being callows, in the top of an earth-mound in the New Forest[40], and Emery reared a small brood in captivity.

On June 25th, 1909, he isolated a deälated female without food—July 7th eggs were laid—July 30th four cocoons and two large larvae present—August 4th the larvae had disappeared—August

12th four very small workers emerged—August 14th more eggs laid and he then gave food to the small colony—September 2nd a naked pupa present, the others that appeared after this were all naked—October 5th an imago emerged, which was just as small as the first brood, as were all the other workers that subsequently appeared[32].

Emery kept a second colony of *glebaria* in captivity in Bologna for eleven years. On June 28th, 1911, he captured a deälated female at large, which he placed in an observation-nest without food. Eggs were laid, and by August 6th four small workers were present. The colony was then fed with honey and flies. A second batch of eggs was laid which hatched and pupated about August 22nd. The imagos (which were as small as the first lot produced when the mother fasted) appeared the first week in September.

On March 28th, 1912, the queen, twenty-three workers, and some eggs, which increased in numbers in the following months, were present. The workers increased in numbers, but though given ample food, the size of those produced in 1913 and 1914 remained small.

In 1918 the numbers of the ants greatly increased, the female was very fertile, and the workers took about three months to develop from the egg ; but only naked pupae occurred.

In 1919 he took away a number of the workers to constitute a queenless colony. He gave them eggs from the old queen, and plenty of food, to see if the workers would bring them up as females, and thus provide themselves with a queen ; but the eggs did not hatch.

In June, 1920, the old queen died, having deposited many eggs, which had always produced workers. In 1921 the workers laid many eggs, which eventually developed into male larvae and pupae. These were devoured by the workers, and in 1923 the colony died out[47].

The following myrmecophiles have been taken with *F. fusca* v. *glebaria* in Britain :—

Coleoptera : *Dinarda pygmaea* Wasm., *Atemeles paradoxus* Gr., *Drusilla canaliculata* F., and *Opatrum sabulosum* L.

Formicidae : *Solenopsis fugax* Latr.

Braconidae : *Blacus compar* Ruthe.

Proctotrupidae : *Gonatopus distinctus* K.

Heteroptera : *Nabis lativentris* Boh., and *Alydus calcaratus*, L.

Aphidae : *Tycheoides setariae* Pass.

Coccidae : *Ripersia subterranea* Newst.

Collembola : *Cyphodeirus* (=*Beckia*) *albinos* Nic.

Araneina : *Evansia merens* Camb., *Dysdera cambridgei* Thor., *Harpactes hombergi* Scop., *Micaria scintillus* Camb., and *M. pulicaria* Sund.

Acarina : *Uroplitella minutissima* Berl., *Laelaps* (*Hypoaspis*) *myrmecophilus* Berl., *L.* (*Oolaelaps*) *oophilus* Wasm., and *L.* (*Cosmolaelaps*) *cuneifer* Mich.

Crustacea : *Platyarthrus hoffmanseggi* Brdt.

Formica fusca L., var. rubescens For.

Formica cunicularia F. Smith Zool. **11** 4080 (1853)[1]. *Formica fusca* var. *fusco-rufibarbis* Forel Denkschr. Schweiz Ges. Naturw. **26** 54–55 (1874)[2]. *Formica rufibarbis* var. *fusco-rufibarbis* Dalla Torre Cat. Hym. **7** 210 (1893)[3]. *Formica fusca* v. *rubescens* Forel Ann. Soc. Ent. Belg. **48** 423 (1904)[4]. [*Formica fusca* v. *fusco-rufibarbis* Schimmer Sitzung. Naturf. Ges. Leipzig **35** 17–18 (1908)[5] ?.] *Formica rufibarbis* Donisthorpe Ent. Rec. **20** 281 (1908)[6] : Trans. Leicester Lit.-Phil. Soc. **12** 223 (1908)[7] [in part]. *Formica fusca* var. *rubescens* Donisthorpe Ent. Rec. **21** 258 (1909)[8] : Zool. **1909** 466[9]. *Formica fusca fusca* var. *rubescens* Emery Deutsch. Ent. Zeitschr. **1909** 196[10] ; Wheeler Bull. Mus. Compar. Zoöl. **53** 498 (1913)[11]. *Formica fusca* var. *rubescens* Donisthorpe Ent. Rec. **25** 66 (1913)[12] : **26** 41 (1914)[13] : **29** 50 (1917)[14]. *Formica* (*Serviformica*) *fusca* subsp. *glebaria* var. *rubescens* Emery Gen. Ins. **183** 247 (1925)[15].

☿ *The large workers have the head anteriorly (clypeus, cheeks, and frontal area), the mandibles, scapes, base of funiculi, thorax, scale and legs yellowish red. The head posteriorly, the apex of antennae, two patches on the thorax (one on the pronotum and the other on the mesonotum, almost fused as in* F. pratensis), *and the gaster are blackish brown.*

The sculpture and pubescence is the same as in *glebaria*. The smaller workers are the same colour as *glebaria*, and are almost indistinguishable from the latter.

Thorax without outstanding hairs. *Long.* 5–7 mm. (4–6·5 mm. *teste Wheeler.*)

♀ *Similar to* glebaria, *but not so dark, with the epinotum and scale almost entirely red.*

I possess a specimen from Fairlight, which has the gaster at the base, sides, and beneath, yellowish red.

Wings infuscate at base. *Long.* 8–9·5 mm. (7–9 mm. *teste Wheeler.*)

♂ *Black ; duller with legs more reddish than in* fusca.

Scale deeply emarginate and appearing lunate. *Wings* darker than in the ♀. *Long.* 8·5–10 mm.

Original description of *Formica fusca* v. *rubescens* Forel [Ann Soc. Ent. Belg. **48** 423–424 (1904)] :—

" Je donne ce nom à la grande variété, à thorax rougeâtre, dans mes Fourmis de la Suisse. Chez la ☿ major, le devant de la tête, le thorax, les scapes, le 1er article des funicules et les pattes sont d'un rouge jaunâtre, sauf deux taches brunes situées sur le pronotum et le mésonotum, taches qui ressemblent à celles de la *F. pratensis* et confluent à peu près. La petite ouvrière se distingue à peine de la var. *glebaria* Nyl. (*fusca* des prés, Forel, Fourmis de la Suisse), la couleur rougeâtre y disparaissant à peu près. La grande ☿ atteint près de 7 mill. ; c'est la plus grande variété de la *F. fusca*, dans nos parages. De même que la v. *glebaria*, elle vit dans les prés, ou elle fait des dômes maçonnés, tandis que la *fusca vera*, qui est bien moins pubescente, un peu plus lisse et plus luisante, vit surtout dans les troncs pourris et sous les pierres. On a confondu encore très souvent la var. *rubescens* de la *fusca* avec la r. *rufibarbis* F., qui a des mœurs fort différentes, et qui est surtout bien plus courageuse. La *rufibarbis* typique, ☿ major, n'a pas les deux taches brunes sur le pronotum et le mésonotum ; seule sa petite ☿ a le thorax en partie brun."

Habitat.

According to Wheeler this variety is known only from Central Europe, and is common in Switzerland[11].

British distribution :—

Devon, S. : Seaton (*Donisthorpe*)[12] ; Sidmouth (*Perkins*).

Dorset : Lyme Regis (*Nevinson*) ; Charmouth (*Donisthorpe*).

Isle of Wight : Landslip (*Donisthorpe*)[13].

Hants, S. : New Forest (*Donisthorpe*)[12].

Sussex, E. : Fairlight (*Donisthorpe*).

Kent, E. : Rodmersham (*Crawley*).

Surrey : Box Hill (*Bedwell*) ; Caterham (*Champion*) ; Woking (*Donisthorpe*).

Essex : Southend (*sub* cunicularia *F. Smith Coll.*)[1] ; Leyton (*Hodson*).

Middlesex : Crouch Hill (*E. A. Butler*).

Gloucester : Kilcot (*Perkins*) ; Combe Hill, Wotton-under-Edge (*Perkins*).

Worcester : Bewdley (*Donisthorpe*)[6 8].

Glamorgan : Horton, Gower (*Hallett*).

Formica fusca var. *rubescens* has the same habits and lives in similar situations to *glebaria*, and in Switzerland it dwells in meadows and constructs earth-mounds.

In May, 1908, I discovered a fine colony of this variety on the side of the railway embankment at Bewdley, its nest being partly situated under a large heavy stone, partly in the bank, with earth built up round the stone[8]. In the New Forest it occurs in earth-mounds, at Seaton under stones, in the Landslip, Isle of Wight, in the side of the cliff, and at Fairlight I found it both in the side of the cliff and in earth-mounds in the undercliff—one of the nests being traced by tracking a worker which was carrying home a fly in its jaws. In 1908 no queen could be found in the Bewdley colony, and when the same nest was visited in July, 1909, many males were found to be present but no winged females, and again no queen was discovered.

It would appear that the queen had died in this colony, and the males had been reared from parthenogenetic eggs laid by the workers[8]. On June, 27th, 1916, this colony was still situated under the same stone at Bewdley and was very populous ; but again no queen could be found. Male pupae were plentiful, but neither female nor worker pupae were present. It seems impossible that a queenless colony could exist, and flourish for eight years, if only male ants were produced. It is probable from our present knowledge that workers have been continually reared from eggs laid by the workers; males from the same source being brought up in their proper season. These males would fly away and

fertilize females from other colonies which would occur in the same district[14].

Many males occurred in the New Forest and Seaton nests in July, 1912, and on August 21st, 1913, a winged female and about a dozen males were found in a nest in the side of the cliff at the Landslip, Isle of Wight. Schimmer records a curious colony of *rubescens* (?), which he discovered at Rösertal, near Seeburg, on May 5th, 1908, consisting of fifteen deälated females, and only twenty to thirty workers. He is of the opinion that this was a queenless nest, which had adopted the deälated females after the marriage-flight, as some of the females were typical *rufibarbis*, whilst others were varieties of *fusca*[5].

Forel points out that *rubescens* has been frequently confounded with *rufibarbis*[4], and it is probable that some of the British records of *cunicularia* and *rufibarbis* really refer to this variety.

I have taken *Cyphodeirus albinos* Nic., *Laelaps myrmecophilus* Berl., and *Platyarthrus hoffmanseggi* Brdt., in nests of *rubescens*.

On June 9th, 1925, I found a nest situated in a bank, facing east, on the undercliff at Charmouth. Many large and red workers were bringing up prey (especially the larva of *Hypera plantaginis*), and by this means the nest was traced. It was dug up and contained sex pupae, eggs, many workers, and a typical *rubescens* queen. After it had been dug up, I noticed what looked like a *rubescens* worker walking about among the rest, but something curious in its movements caused me to bottle it. It then proved to be a fine male of the ant-mimicking spider *Myrmarachne formicharia* De G.! It was coloured exactly like the redder workers of the ant.

Formica rufibarbis F.

Formica rufa Fourcroy Entom. Paris 2 452 (1785)[1]. *Formica pratensis* Olivier Encycl. Méthod Ins. 6 504 (1791)[2]. *Formica rufibarbis* Fabricius Ent. Syst. 2 355 (1793)[3]. *Formica obsoleta* Latreille Ess. Hist. Fourmis France 38 (1798)[4]. *Formica cunicularia* Latreille Ess. Hist. Fourmis France 40 (1798)[5] : Hist. Nat. Fourmis 151–156 (1802)[6]. [" La fourmi mineuse " Huber Mœurs Fourmis 324–325 (1810)[7].] *Formica cunicularia* Nylander Acta. Soc. Sc. Fenn. 2 913–915 1059 (1846)[8] ; Förster Hym. Stud. 1 25 (1850)[9]. *Formica stenoptera* Förster Hym. Stud. 1 26 (1850)[10]. *Formica cunicularia* F. Smith Proc. Ent. Soc. Lond. (n.s.) 1 82 (1851)[11] ; Schenck Jahrb. Ver. Naturk. Nassau 8 40–43[12] 139[13] 145[14] (1852) ; Mayr Verh. Zool. Bot. Ver. Wien 5 342–344 (1855)[15] ; F. Smith Trans. Ent. Soc. Lond. (n.s.) 3 103 (1855)[16] [in part] : Cat. Brit. Foss. Hym. 8 (1858)[17] [in part]. *Formica fusca* r. *rufibarbis* Forel Denkschr. Schweiz Ges. Naturw. 26 54[18] 138[19] 141[20] 218[21] 357–358[22] 408[23] (1874). *Formica cunicularia* Saunders Trans. Ent. Soc. Lond. 1880 206[24] [in part]. *Formica rufibarbis* Er. André Spec. Hym. Europe 2 182 (1881)[25] ; Lubbock Ants, Bees, Wasps 80 (1881)[26] ; Wasmann Stet. Ent. Zeit. 51 305 (1890)[27]; Dalla Torre Cat. Hym. 7 209–210 (1893)[28]. *Formica cunicularia* Farren-White Ants' Ways 182 199 233 (1895)[29] [in part]. *Formica fusca* race *rufibarbis* Saunders Hym.-Acul. 22 (1896)[30] [in part]. [*Formica cunicularia* Vic. Hist. Hants 1 115 (1900)[31] ?] ; Vic. Hist. Surrey 1 84 (1902)[32]. *Formica rufibarbis* Wasmann Mitt. Schweiz Ent. Gesell. 11 67–69 (1905)[33] ;

Frisby Proc. Holmesdale NH. Club **1905** 74 (1906)[34]; [Vic. Hist. Kent **1** 119 (1908)[35] ?] *Formica fusca* race *rufibarbis* Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 223 (1908)[36] [in part]. *Formica fusca rufibarbis* Emery Deutsch. Ent. Zeitschr. **1909** 197[37]. *Formica rufibarbis* Wasmann Archiv. Trim. Inst. R. Grand Ducal Luxemburg **4** 81–88 (1909)[28]; [Silverlock Nat. **35** 13 (1910)[39]?] *Formica fusca* subsp. *rufibarbis* Donisthorpe Entom. **44** 390 (1911)[40]: Ent. Rec. **25** 66–67 (1913)[41]. *Formica rufibarbis* Wheeler Bull. Mus. Comp. Zoöl. **53** 514–516 (1913)[42]; Donisthorpe Ent. Rec. **26** 41 (1914)[43]: **28** 3 (1916)[44]. *Formica* (*Serviformica*) *fusca rufibarbis* Emery Bull. Soc. Ent. Italiana **47** 255 (1916)[45]. *Formica rufibarbis* Wheeler Psyche **29** 175 (1922)[46]; Donisthorpe Ent. Rec. **34** 82 (1922)[47]; Wheeler Amer. Mus. Novit. **69** 4 (1923)[48]. *Serviformica rufibarbis* Lomnicki Bull. Ent. Pologne **3** 28–32 (1924)[49]. *Serviformica glebaria* Lomnicki [in part] Bull. Ent. Pologne **3** 31 (1924)[50]. *Serviformica rubescens* Lomnicki [in part] Bull. Ent. Pologne **3** 31 (1924)[51]. *Serviformica rufibarbis* F. var. *piliger* Lomnicki Bull. Ent. Pologne **3** 30 (1924)[52]. *Formica* (*Serviformica*) *rufibarbis* Emery Gen. Ins. **183** 249 (1925)[53].

☿ *The large ☿ has the clypeus, cheeks, frontal area, scapes and base of funiculi, whole of thorax, scale and legs clear pale red, or reddish yellow; head posteriorly and gaster blackish brown. The mandibles are red brown, tarsi with last joint slightly infuscate; the pubescence on gaster gives it a greyish appearance.*

The medium and small workers possess brown patches on the pronotum

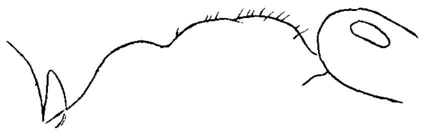


Fig. 92. Side view of thorax of *Formica rufibarbis* ☿.

and mesonotum; and in the small workers the brown colour is sometimes spread over the whole body as in *glebaria*.

Structure and form much as in *fusca*, more hairy, and with longer and closer pubescence. *Head* opaque, not quite so dull as thorax; *clypeus* distinctly carinate; *frontal area* punctured. *Thorax* opaque; *pronotum* furnished with very distinct scattered outstanding yellow hairs, in both large and small specimens. *Scale* large, broad, rounded, sometimes with a few outstanding hairs; *gaster* with scattered outstanding yellow hairs. *Long.* 4·6–7·5 mm. (4–7·5 mm. *teste Wheeler.*)

♀ *Cheeks, clypeus, frontal area, mandibles, scapes and base of funiculi, pronotum, mesonotum and scutellum in part, scale, apex of gaster and legs lighter or darker yellowish red; rest of head, mesonotum with three longitudinal patches, scutellum, post scutellum and gaster blackish brown.*

Structure and form of *fusca*. *Thorax* with outstanding hairs, longer and more abundant than in the *fusca* vars. *Wings* greyish, veins brown yellow, *pterostigma* darker. *Long.* 9–10 mm. (9–11 mm. *teste Wheeler.*)

♂ *Black; legs yellow with nearly the whole of the tarsi, and base of femora blackish (sometimes only the extreme base of the femora, and the apex of the tibiae are dark, or the whole of the legs may be mostly blackish); genitalia reddish yellow.* Shape and structure as in *fusca;* duller in appearance. *Head* with more distinct decumbent yellow hairs on *cheeks* and *clypeus* than in *fusca* or its vars. *Thorax* with distinct outstanding yellow hairs. *Scale* only slightly, or widely but not deeply, emarginate, furnished with outstanding hairs; *gaster* more closely punctured than in *fusca*, with shorter closer pubescence, and some outstanding yellow hairs. *Wings* a little darker than in the ♀. *Long.* 8·5–11·8 mm. (9–10 mm. *teste Wheeler.*)

Original description of *Formica rufibarbis* **Fabricius** [Ent. Syst. 2 355 (1793)] :—

" F. oblonga nigra ore thoraceque rufis.
Habitat in Gallia.
Media. Antennae nigrae. Caput nigrum ore late rufo, qui color ad latera extenditur.
Mandibulae tamen nigrae. Thorax rufus, immaculatus.
Squama petiolaris ovata, obtusa. Abdomen ovatum, atrum, immaculatum. Pedes nigri."

Habitat.

Widely distributed through Europe and Northern Asia, and occurring in Sardinia, though absent from the smaller Mediterranean islands. It is a distinctly xerothermal form, and in the Alps does not reach such an elevation as the typical *fusca.* According to Ruzsky, however, it occurs at an altitude of 3000 m. in the Caucasus, and according to Forel even higher in the Himalayas[41].

W. L. Distant took three workers and a female of this species in Pretoria, South Africa, only a short distance from the tropic of Capricorn (26° S.)[46]. These ants no doubt had been directly imported from Europe.

Six varieties of this species had been described, two of which live in North America ; and recently Wheeler has described another from Tsingtao, Shantung, China[48].

British distribution :—

Surrey : Reigate (*Frisby*)[34] ; Ripley (*Arnold*)[36] ; Chobham (*Saunders*) ; Weybridge (*Donisthorpe*)[41].

Wheeler considers *Formica rufibarbis* F. to be a good species[42], and not a subspecies of *F. fusca* L., as its habits, its instincts, and its behaviour when alive are quite different.

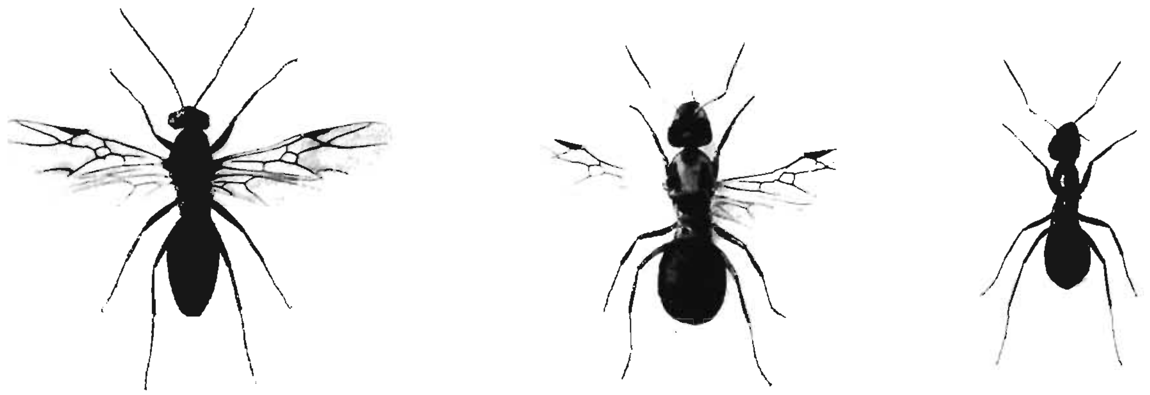
It is more agile, fearless, and warlike than the varieties of *fusca,* not being a cowardly species like *fusca,* and it possesses a distinct aromatic odour, which is also present in the American forms. Forel says in Switzerland it loves dry slopes, and lives in meadows, on the borders of roads, in uncultivated places, very rarely in gardens ; but it does not nest near houses, and never occurs in woods[21].

This species is well called the mining ant by Huber[7], as it nests in the ground ; it has been recorded as living under stones, and sometimes constructing small earth-mounds, but I suspect the two latter situations really refer to the var. *rubescens* of *fusca,* and Emery distinctly states it nests under the ground without any earth construction above[37].

I have found *rufibarbis* at Weybridge, nesting in sandy banks, on the borders of paths, and under turf and herbage.

The nest, which is often very difficult to find on account of its

PLATE XVII.



Male, female, and worker of *Formica rufibarbis*.

Face page 370.

hidden nature, is situated about a foot below the surface of the ground, and the entrance consists of a small hole, sometimes concealed by a tuft of grass, or herbage.

A small chamber at the bottom of the nest contains the queen, or queens, and galleries all lead to the single entrance above ground.

This very active species lives an open-air life, and possesses more individual initiative than *F. rufa*; its workers hunt singly, catching flies and other insects, and they never forage in troops, nor execute joint excursions.

Frisby records their visiting flowers, and being especially partial to the flower-heads of *Heracleum* and other umbelliferous plants[34], and I have seen workers basking in the sun on the leaves of brambles.

The workers are very audacious and will even endeavour to rob *rufa* of its prey—holding on and pulling—and the moment the *rufa* lets go, to get a better grip, or to attack the *rufibarbis*, the latter swiftly decamps with the prize; and should a *rufa* grasp it by a leg or an antenna, it remains quite still, and when its opponent loosens its grip, the better to kill it, it quickly slips away.

This species finds its way by sight alone, as it does not follow beaten tracks, and when it has captured a booty it returns in a straight line to the nest. Wasmann records that on May 10th, 1907, in a garden at Luxemburg, he observed two workers, the one carrying a fly-larva, the other a dead beetle (*Silpha atrata*), return in a straight line from different directions to their nest[38].

On July 12th, 1913, having observed several *rufibarbis* workers running about on a path near a sandy bank at Weybridge, I endeavoured to find their nest, and commenced to pull up handfuls of herbage on the top of the bank, which I let fall on the slope. I then saw a worker approaching with a fly in its jaws and start to mount the bank, and as the scattered herbage was directly in its way, I feared the ant might be diverted from its nest, but when it reached the obstacle it never hesitated for a moment, but running straight over it in a direct line, entered its nest on the top of the bank, which I was thus enabled to find.

Forel says the colonies of *rufibarbis* are sometimes small, but usually of medium size, and none that I have found have been large; Wasmann, on the other hand, records large colonies at Luxemburg consisting of over one thousand workers, and says they are generally more populous than those of *fusca*[38]. Schenck often found naked pupae in *rufibarbis* nests at Nassau[12], and I have had such pupae produced in my observation-nest from Weybridge.

Forel[19] and Wasmann[38] record pseudogynes of *rufibarbis*, and the former describes a mixed gynandromorphous specimen which he

captured on the wing, flying with normal males and females at the summit of Monte Salvatore on July 1st, 1891:—

Halves of head identical, but of such a character that it is impossible to say whether they are male or female ; in form the head is exactly intermediate between the two sexes. Both antennae thirteen-jointed as in the male, but scapes too long in proportion to funiculi for this sex. Mandibles indistinctly denticulate, parti-coloured reddish black and brown, intermediate between male and female, as are also the size and conformation of the eyes and ocelli. Whole head more robust than that of the male, smaller than that of the female ; black (hence male). Thorax indeterminate ; right half of epinotum yellowish red, left half black, whereas the right half of the scutellum and petiole is black, the left half reddish yellow ; hence the epinotum is female on the right, male on the left side ; whereas the scutellum and petiole are male on the right and female on the left. The three pairs of legs are symmetrical, yellowish, and have rather the form of the female. The wings, being the same in both sexes, are indeterminate in the gynandromorph. Gaster apparently female, globular, very small, with five segments, excluding the petiole. Anus round, encircled by hairs as in the female, but it opens above into a transverse, eciliate slit, situated between the hypopygium and pygidium as if forming a second anus. The anus proper is cut into the hypopygium[26].

On July 29th, 1913, I captured a curious individual, which was running rapidly among the workers in a nest of *rufibarbis* at Weybridge, and which I at first took to be a pterergate, as it had the general appearance of a large worker with wing stumps, but when set and studied more carefully it appears to be an ergatandromorphous specimen which may be described as follows :—

Head shape and size of large ☿, black except mandibles and cheeks anteriorly, which are reddish yellow ; *median ocellus* large ♂ ; *lateral ocelli* small ☿ ; *mandibles* ☿ ; *antennae* shape and size of ☿, twelve-jointed, outer half of left *scape* blackish brown longitudinally, right *scape* with a blackish brown patch on outer anterior corner. *Thorax* ☿, reddish yellow, with larger and smaller blackish brown spots dotted irregularly about ; *pronotum* with distinct outstanding yellow hairs ; *metanotum* furnished on left side with a short deformed wing, 2 mm. in length, right side with only a small chitinous tubercle. *Scale* ☿ ; *gaster* long, but with sculpture, pubescence, and bristles of ☿ ; ♂ *genitalia* short, thick, and deformed, exposed at apex of gaster. *Legs* intermediate between ♂ and ☿ ; *coxae, femora,* and *tibiae* of intermediate and posterior pairs infuscate, rest of legs and *tarsi* yellowish, left posterior leg with femora and tibia deformed, bowed. *Long.* 8 mm.

Wasmann has found that gynaecoid workers occur, one, or more, acting as substitute queens in queenless nests of *rufibarbis.* At Luxemburg in 1904 he possessed two such workers which were treated as are true queens, being fed and cleaned and attended on by the workers ; their gasters were swollen and they laid a number of eggs. He says this proves that it is possible for ants, by better feeding, to bring up ordinary workers, after they have hatched, as egg-laying individuals, and use them as substitutes in the place of true females[33].

In his experience it is not usual to find many, or more than one

deälated female in a *rufibarbis* nest ; I have, however, found five, three, and two deälated females in single nests at Weybridge.

Nylander found the males and winged females in the nests in Finland from July 20th to August 10th[8] ; Schenck gives July 9th to 21st at Nassau[12], but he captured a male on October 3rd, and he says the winged females are much less abundant than the males, as he only once found the former, but frequently observed the latter in many nests[12 14]—this has also been the case in my experience at Weybridge. Smith mentions a winged female which was captured in flight by S. Stevens on April 18th, 1851[11]—but this would probably be a specimen from the year before which had passed the winter in the nest—and Forel records the winged forms in the nest in Switzerland in June, July, and August[23].

The occurrence of the sexes appears to be very erratic with this species, and I was never able to find any until 1914, having dug up *rufibarbis* nests for three years at Weybridge—in May, June, July, August, and September—and neither males or winged females, nor sex larvae or pupae occurred.

On June 5th, 1914, a nest was found which at last contained large (sex) larvae, a few of which I took home and introduced into my *rufibarbis* observation-nest, but as the workers would not have anything to do with them—throwing them out of the nest every time I put them back—I returned them to their own nest at Weybridge, where they were taken in by the workers. On July 1st I went down again, but found that my nest had been dug up and destroyed ; however three more colonies were discovered, only one of which contained sex pupae. A few of these large cocoons were taken home, two of them were introduced into my observation-nest, and the rest were placed in a tin with a little earth and some of their own workers.

On July 4th four more colonies were discovered, only two of which contained sex pupae, and a few of these were taken home from one of the nests and placed in the tin with the others.

Males emerged on July 9th and 10th ; the ants in my observation-nest having accepted the two cocoons, only one of which hatched however. On July 16th ten more nests were found, nearly all of which contained males in some numbers, but only one winged female was observed. On July 30th, 1915, several winged females and a few males were found to be present in one nest at Weybridge[44].

Forel states the marriage-flight takes place in July at about seven o'clock in the morning, when he saw males and winged females flying at the summit of Mont Tendre[23], as before mentioned, and André gives June and July[25]. On August 3rd, 1914, all the winged sexes had disappeared from the nests at Weybridge.

The queens found their colonies in the normal manner as, we have seen, do all the *fusca* group.

Wasmann records finding a small incipient colony at Shötter

Marial on July 25th, 1906, which consisted of a deälated female, about fifty young small workers, and twelve naked worker pupae. The queen was resting in a small chamber about the size of a hazel nut, and empty cocoons were scattered about outside the nest, which he concluded had been removed from the pupae by the workers[38].

My observation-nest of this species was taken on July 10th, 1912, but the queen did not lay eggs till January 27th, 1913; and again on April 2nd and 17th, 1914; July 14th, 1915; April 2nd, 1916; April 8th and June 4th, 1917; and from these eggs workers were reared.

The queen died on August 7th, 1917. In 1918 several of the workers, which were very swollen and evidently gynaecoids, laid eggs—on February 28th, March 17th, and April 6th. Larvae hatched and cocoons were spun up (evidently workers from their size); but unfortunately they went mouldy, and the ants did not emerge. A number of the ants died off, so the remaining ones were let loose on August 1st, 1918. Twice—on July 8th, 1916, and July 4th, 1918—workers were brought up from *rufibarbis* nests at Weybridge and introduced into this nest, when they were well received. Two very curious cripples were produced, which were quite unable to walk, but lived for some time in the nest. Both the antennae, the labial palpi, and all six legs were deformed; being twisted in all directions[47].

I have never been able to find any beetles (which are the usual guests) with these ants, although *Atemeles paradoxus* and *Dinarda pygmaea* occur with them on the Continent, and the only myrmecophiles I have observed are one *Leptacinus formicetorum* Märk (a guest of *F. rufa*), *Pachylomma buccata* Nees, hovering over the ants, *Platyphora dorni* Ender., bred from the ant's pupae, and *Cyphodeirus albinos* Nic., in the nests.

Formica picea Nyl.

Formica picea Nylander Acta. Soc. Sc. Fenn. **2** 917[1] 1059–1060[2] (1846); **3** 27 (1849)[3]; Förster Hym. Stud. **1** 30–31 (1850)[4]; Schenck Jahrb. Ver. Naturk. Nassau **8** 126 (1852)[5]. *Formica gagates* Mayr Verh. Zool. Bot. Ver. Wein **5** 347–350 (1855)[6] [in part]; Nylander Ann. Sc. Nat. **5** 65 (1856)[7]; Meinert Kong. Danske. Vidensk. Selsk. Skrift. **5** 316 (1861)[8]; F. Smith Ent. Ann. **1866** 127[9]; Sahlberg Meddel. Sco. Faun-Flora Fenn. **1** 134–136 (1876)[10]; "*Formica gagates* Olivier-*picea* Nyl" Cornelius and v. Hagens Jahr. Nat. Elberfeld-Barmen **5** 104 (1879)[11]. *Formica gagates* Saunders Trans. Ent. Soc. Lond. **1880** 207[12]; Stolpe Ent. Tidskr. **3** 133 (1882)[13]. *Formica glabra* Farren-White Ants' Ways 80[14] 253[15] (1883). *Formica gagates* Saunders Ent. Mo. Mag. **20** 16 (1885)[16]. *Formica fusca* race *gagates* Adlerz Bih. Sv. Vet.-Akad. Handl. **11** 308 (1886)[17]. *Formica transkaukasica* Nassonow Imp. Obshch. Lyrrb. Est-Ant-Etn. Mosc. **58** (1) 62 [=Tr. Lab. Zool.-Mus. **2** (1) 62] (1889)[18]. *Formica gagates* Dalla Torre Cat. Hym. **7** 198–199 (1893)[19] [in part]. *Formica glabra* Farren-White Ants' Ways (Ed. 2) 5[20] 83–84[21] 234[22] (1895). *Formica fusca* race *gagates* Saunders Hym.-Acul. 22 (1896)[23]. *Formica ?gagates* Ruzsky

Form. Imp. Ross. 378 (1905)[24]. *Formica fusca transkaukasica* Ruzsky Form. Imp. Ross. 384 (1905)[25]. *Formica fusca* race *gagates* Arnold Ent. Mo. Mag. **41** 211–212 (1905)[26]. *Formica fusca* subsp. *gagates* v. *filchneri* Forel Ann. Soc. Ent. Belg. **51** 208 (1907)[27]. *Formica fusca picea* Emery Deutsch. Ent. Zeitschr. **1909** 195[28]; Bondroit Ann. Soc. Ent. Belg. **53** 483 (1909)[29]. *Formica fusca* subsp. *gagates* Donisthorpe Entom. **44** 390 (1911)[30]. *Formica picea* Reichensperger Bonn. Sitz. Ber. Nat. Ver. (E) **1911** 122[31]; Bondroit Ann. Soc. Ent. Belg. **56** 352 (1912)[32]; Donisthorpe Ent. Rec. **24** 306 (1912)[33]: **25** 67–68 Tf. 1–2 (1913)[34]. *Formica fusca picea* Wheeler Bull. Mus. Compar. Zoöl. **53** 512 (1913)[35]; Bönner Biol. Centralb. **34** 59–76 Tf. 1–6 (1914)[36]; Wasmann Biol. Centralb. **34** 76–80 (1914)[37]; Adlerz Arkiv. Zool. **8** 1–5 (1914)[38]. *Formica* (*Serviformica*) *picea* Emery Bull. Soc. Ent. Italiana **47** 254 (1916)[39]. *Formica picea* Kutter Biol. Zentralb. **37** 436 (1917)[40]; Donisthorpe Ent. Rec. **30** 9 (1918)[41]: **31** 25 (1919)[42]; Wheeler Psyche **29** 175 (1922)[43]; Donisthorpe Ent. Rec. **35** 6 (1923)[44]. *Formica* (*Serviformica*) *picea* Emery Gen. Ins. **183** 249 (1925)[45].

Dalla Torre[19] incorrectly cites *F. picea* Nylander and *F. glabra* Farren-White as synonyms of *F. gagates* Latr.

In 1918 I pointed out that Dr. Leach had described an ant found in the environs of Nice as *Formica picea* [Zool. Journ. **2** 289–93 (1825)], de Dalla Torre considers this to be *Camponotus lateralis* Ol., v. *picea* Leach. As Leach's name has twenty-one years' priority some entomologists consider that Nylander's name must fall[41]. I do not, however, intend to follow such a course in the present work.

☿ *Shining, lighter or darker blackish brown, mandibles, the greater part of the antennae, and legs pale reddish brown. In the lighter specimens only the head posteriorly and the apex of the antennae are dark, in the darker specimens the whole body and the apex of the antennae are blackish, and the femora are infuscate.*

Head much smoother than in *fusca,* finely alutaceous; *cheeks* and *frontal area* more shining, being more finely shagreened. *Thorax* smooth, very finely shagreened, pubescence very scanty, scarcely visible except at sides of *epinotum; pronotum* and *mesonotum* furnished with outstanding yellow hairs—especially on the former, in which they are longer; *epinotum* seen in profile, distinctly angled. *Scale* rounded; *gaster* smooth and shining, finely alutaceous, pubescence very sparse and scattered, with outstanding yellow hairs or bristles. *Long.* 4·4–5·5 mm. (4–6·5 mm. *teste Bonner.*)

♀ *Shining black, much smoother than in* fusca, *mandibles, legs, and scape brownish red.*

Head (apart from the mandibles) about as broad as long, but a little shorter and broader than in *fusca,* the sculpture consisting of very close scratches (alutaceous puncturation) with some distinct small scattered punctures; *clypeus* entire, more sharply and distinctly carinate than in *fusca; frontal area* finely punctured but more shining than in *fusca; eyes* apparently a little smaller than in *fusca,* with facets somewhat smaller and closer. *Thorax* not so distinctly broader than head as in *fusca,* with more abundant, more distinct and longer hairs, pubescence almost nil, even on the epinotum; *mesonotum* simply alutaceous, with a few large and small scattered punctures; *scutellum* almost entirely smooth, very shining. *Scale* rounded much as in *fusca; gaster* very finely alutaceous transversely; almost impunctuate, and without pubescence, furnished with long outstanding yellow hairs, besides the bristles on the margins of the segments. Legs with less fine and close pubescence than in *fusca. Long.* 8–9 mm.

♂ *Black, more shining than in* fusca, *antennae all black, mandibles black,*

scarcely lighter at the apex, legs yellow with tibiae at base and last joint of tarsi darker, femora blackish, genitalia partly yellow, partly blackish.

Head narrow anteriorly; broad posteriorly, sculpture smoother and finer than in *fusca; frontal area* smoother and more shining; *eyes* not quite so convex; space at base of *frontal furrow* smoother and more shining. *Thorax* not as distinctly broader than the head, furnished with abundant, long, yellow hairs; *mesonotum* shining, alutaceous. *Scale* not, or scarcely, emarginate, thicker and blunter, with some outstanding hairs; *gaster* shining, alutaceous, with some outstanding hairs, and with longer, and more widely separated pubescence. *Wings* very pale brown, not as dark as in *fusca,* with pale brown veins and darker *pterostigma. Long.* 7–7·5 mm. (9–10 mm. *teste Bönner.*)

Original description of *Formica picea* Nylander [Acta. Soc. Sc. Fenn. 2 917 (☿). 1059–1060 (♀, ♂) (1846)]:—

"*Operaria:* piceo-nigra nitidissima; mandibulis, antennis pedibusque piceis; ocellis minutis; squama subtriangulariter rotundata; abdomine inprimis albo-pilosulo.

Hujus speciei neglectae hucusque tantum operariam parcius in sphagnosis ad Helsingfors et Uleåborg inveni; diffusa igitur saltem per totam patriam videtur.

☿ Long. circiter 2 lin. Simillima sequenti. Nigra tota, mandibulis tantum et antennis piceo-rufescentibus, flagellis obscurioribus; pedibus quoque trochanteribus, geniculis et tarsis rufescentibus, tibiis femoribusque interdum ejusdem fere etiam coloris. Caput magnitudinis mediocris et formae sicut in *F. rufa,* pilis parcis albidis conspersum. Palpi maxillares atri ut in *F. rufa* constructi. Clypeus distincte carinulatus. Area frontalis sat distincte limitata, nitore reliquarum partium capitis. Oculi majores quam in praecedente ovales, paulo prominuli. Occiput (minime ut in praecedente emarginatum) aequaliter convexiusculum. Thorax nitidus subtilissime sparse adpresse albido pubescens, pilis nonnullis erectis in pronoto, depressione inter pulvinar pro- et mesonoti atque metanotum minori quam in *F. rufa,* aliis proportionibus fere iisdem ac in hac specie. Squama altitudine abdominis sursum paullo latior, angulis parum rotundatis, supra subtruncata vel margine convexiusculo. Abdomen nitidissimum nigrum (nitore cinereo-sericeo ne minimo quidem), supra visum rotundatum, capite latius, pilis longiusculis sparsis albidis solito more ante margines segmentorum serie et alibi rarius dispositis. Pedes adpresse subtiliter cinerascenti-pubescentes, tibiis latere interiori setulis nonnullis."

"*Formica picea* ☿ et ♀ exalata, e Sibiria. *Femina* (antea ignota) similis est *F. glebariae* ♀, at pili parvi corporis crebriores et rigidiusculi, pubescentia depressa subtilis obsoletissima, thorax contractior altior, longitudine abdominis, fere aeque altus ac longus (in *glebaria* ♀ thorax altitudine sua duplo longior est); pedes obscure fusci articulationibus tarsisque rufescentibus similiter ac flagella antennarum; abdomen latiusculum, nigrum ut corpus ceterum (in *glebaria* ♀ interdum parum aenescens). *Mas.* e Sibiria, qui forte *F. piceae* pertinet; similis est magnitudine et statura mari *F. rufae,* sed subnudus atro-niger totus, articulationibus pedum superioribus obsolete rufescentibus, squama paulo majori transversaliter (hàrizontaliter) rectangulari-oblonga supra integra; alae totae albescenti-hyalinae, versus basin solum obsoletissime brunnescenti-tinctae, nervis et stigmate fuscis, anticae 9¼ millimetra longae. Area frontis triangularis (sicut caput ceteroquin et thorax) opaca."

Habitat.

Formica picea ranges over Northern Europe and Asia to East Siberia, and occurs in Britain, Belgium, Luxemburg, Holland, Germany, Sweden, Denmark, Finland, Russia, China, and Thibet, etc.

In 1913 Forel described a var. *formosae* of *F. picea* [H. Sauter's Formosa Ausbeute Formicidae II. Arch. Naturgesch. **79** 183–202 (1913)] from Taihorin, Formosa, which is on the Tropic of Cancer. *F. picea* is a boreal European ant, usually found in peat-bogs. Forel's variety may perhaps occur at a considerable elevation in the mountains, which in Formosa rise to an altitude of 7000 to 14,000 feet. In this case, therefore, we may be dealing with a relict instead of a recent importation[43].

British distribution :—

Isle of Wight : ? (*F. Smith Coll.*).

Dorset : Wareham (*Dale Coll.*).

Hants, S. : Bournemouth (*F. Smith*)[9]; New Forest (*Arnold* and *Piffard*).[26]

Glamorgan : Rhosilli (*T. W. Allen*).

Formica picea was described by Nylander in 1846[1], in 1855 it was incorrectly sunk by Mayr as a synonym of *F. gagates* Latr.[6], and curiously enough, Nylander, in 1856, followed Mayr in treating his own species as a synonym of *gagates*[7]. Nylander's species was again brought forward by Emery in 1909, who distinguishes it from *gagates* by the shape of the epinotum, and points out that the latter is a more southern and westerly form than *picea*[28]. I possess specimens of *gagates* from Vienna.

Its history as a British insect is as follows :—In 1866 F. Smith added it to the British list, on specimens taken by his son at Bournemouth, under the name of *gagates*[9], but he subsequently regarded it as distinct from that species and believed it to be a curious form of *fusca*, and in 1880 Saunders again brought it forward as a British insect as *gagates*[12]. In 1883 Farren-White rightly considered it to be distinct from that insect, and gave it the name of *glabra*[15], but Saunders in 1885, when criticizing Farren-White's views, again attributes it to *gagates*, and though he admits our specimens are undoubtedly smaller and paler than Continental ones, he remarks that surely it is more likely to belong to a known form on the Continent than to a new species[16]. This was true enough, but it did not follow that our species must be *gagates*. In 1892 and 1893 Farren-White rediscovered *picea* at Bournemouth[20], taking a female and many workers, and he says the differences between this species and Continental *gagates* are most marked[21], that it is sufficiently distinct to form a new species[22], and he retains his name *glabra* for it ; but in 1896 Saunders again refers to it as *gagates*[23].

In 1905 Arnold and Piffard discovered *picea* in the New Forest, and Saunders having named these specimens *gagates*, they were recorded as such[26].

In 1912 Crawley and I again found it in the New Forest, and I pointed out that the British species doing duty under the names of

glabra and *gagates* was *picea*[33]; and in 1913 I reviewed the British captures to date, and published drawings to show how it differed from *gagates* both in the shape of the epinotum and of the scale[34]. In the same year I detected a specimen kindly sent to me among some ants from Rhosilli by Mr. T. W. Allen, and in 1914 I first discovered two, and subsequently five, colonies of *picea* in the New Forest, which will be mentioned again presently.

Bönner[36], in an interesting paper on the history and habits of this ant, published in 1914, lists and discusses the literature of the subject, but he does not appear to be aware of the observations of Farren-White, Arnold, or Donisthorpe. He refers, however, to Saunders's record in 1880 of *F. gagates* as British, stating that he holds it for certain that Saunders's examples belong to *F. picea,* in which of course he is quite correct.

F. picea Nyl. is abundantly distinct from *F. gagates* Latr., both

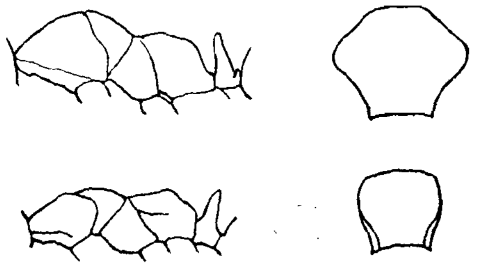


Fig. 93. 1. Thorax and scale of *Formica gagates* ☿.
2. „ „ *Formica picea* ☿.
(Donisthorpe.)

in structure and in habits. In the former the individuals are on the average smaller, the epinotum is angled and the scale is rounded (—at any rate it is never formed as in *gagates*, which has a scale similar in shape to that of *F. rufa ;* I have called it hexagonal in this work, and Latreille himself describes it as " squama magna, ovata : margine supero medio elevato, truncato, subbidentato " [Hist. Nat. Fourmis 138 (1802)]—), in the latter the epinotum is quite rounded. *F. picea* dwells in sphagnum bogs ; *F. gagates* lives in oak forests, nesting under large stones and at the roots of trees, and attending aphides on oak trees.

Wheeler regards *gagates* as an independent species, and not as a subspecies of *fusca* [Bull. Mus. Compar. Zoöl. 513 (1913)], and I consider *picea* also to be a good species, as it is abundantly distinct from *fusca* in the worker, female and male, and its habits are quite different ; Bondroit told me he also considered it to be a good species.

F. picea lives in wet places, and constructs small hillocks of bits of cut sphagnum, grass, etc., over its nests, the whole often soaked with water, and the ants and their brood living below the surface of the bog.

(H. Kutter found several colonies of this ant at a height of 1800 metres at Tschamut in Switzerland, in the middle of August, 1916. The ants had built themselves earth-nests ; and though the earth was slightly damp, there was no trace of a sphagnum bog near by. This of course was exceptional, and contrary to the usual habits of *picea*[40].)

Nylander, as we have seen in the original description of *picea*, records it at Helsingfors and Uleåborg " in sphagnosis "[1], and again subsequently at Kuusamo " in sphagnosis "[3].

Farren-White only states he found the ants on the open heath[22], but Arnold describes the nest found by him as follows :—" When collecting in the New Forest this July, a friend called my attention to a peculiarly shaped ants' nest in Matley Bog. In the part in which it was situated the ground was covered with tussock grass, each tussock forming a little hillock from one to two feet high, the ground between and below the tussocks being wet and mossy. On the top of one of these tussocks was a nest, in the shape of a cone, composed of very small bits of dried grass. It was about 9 inches high, and 4–5 inches wide at the base, the whole supported by the blades of tussock grass on the sides, while some of the blades sprang out from the top, forming a sort of pillar in the middle of the nest "[26].

Arnold's " moss " between and below the tussocks would be sphagnum, and I suspect a part of the nest also consisted of sphagnum.

Saunders showed me a sketch of this nest which Arnold had made, but he unfortunately suggested that it was only constructed in this manner, on account of the nature of the ground in which it happened to occur, whereas these are the habits and situation peculiar to *picea*, and it is a splendid instance of the help that biology can give to the systematist.

On July 23rd, 1912, Crawley and I visited Matley Bog specially to hunt for nests of *Formica picea ;* the part of the ground we explored was very dry at the time, but a colony of ants was discovered deep in a clump of sphagnum, which we at once recognized as this species on account of their very shining appearance. A number of workers and large cocoons were secured—the latter hatched at the end of July and the beginning of August and all proved to be males—but no females, nor queen, were found[34].

Allen told me the specimen of *picea* he sent to me from Rhosilli in 1913 was taken in a marshy spot.

In January, 1914, Bönner, and in February, 1914, Adlerz, independently published papers on this interesting species,

the one calling it a "Moorameise"[36], the other "Torfmossarnas Myra"[38].

On September 9th, 1912, the former author found an ants' nest in a "Torfmoor" (sphagnum) at Lyngbymoor, two hours from Copenhagen, which he thought belonged to *F. gagates*, but Wasmann told him it was *F. picea;* and in July, 1913, they together visited the same locality.

This spot appears to be most admirably suited to *picea*, as Bönner says that at least one hundred and fifty nests occur in an area of two hundred metres long by eighty broad.

To get at the nests it is necessary to walk up to the ankles in water, the bog quaking, and if one stands still one sinks deeper, as where it is dry no nests occur, though they are not found in the very wettest parts where one would sink altogether; but the largest and most populous nests were often found on a higher and drier spot, which was merely surrounded by water.

The nests he found, which consisted of white hillocks composed of the leaves and stems of sphagnum collected together, varied from the size of a tennis-ball to half a "qm."—most nests measured one to two "dm." in diameter—and part of the nest was always situated five to seven "cm." below the surface.

They were like a sponge, and when squeezed water ran out of them; only the chamber in the upper part of the dome and the entrances to the galleries being dry.

He often noticed grass stems growing through the nest, which at first he thought acted as pillars, in the same way as *A. niger* uses grass stems to support its architecture, but he subsequently found that a number of black aphides were seated on these grass stems and sucking the juices from them; it is probable that the ants had built the nest round the stems on this account. In the hillocks he found cocoons, but rarely larvae, though in the hot weather most of the colony came up into them.

He says that not all nests are covered by a hillock, but that in such cases he never found the winged sexes nor brood in them. The colonies consisted of from fifty to one thousand individuals, but usually of six to eight hundred.

As he points out, the shining greasy ("fettige") chitinous covering of these ants enables them to live in such wet places, but they always have wet feet, which can be proved by allowing them to walk over a pane of glass, when the wet marks made by their feet can be seen.

He found the winged females and males in the nests in July and August, but never in September, the females always being more abundant; on the other hand, as we have seen, Crawley and I only obtained males in 1912, and in 1914 I found this sex to be far more abundant than the females. The worker pupae were usually in cocoons, but in September and later they

were often naked, and he states he does not know how the colonies are founded.

On September 9th, 1912, he fixed up a small colony in a "Lubbock" nest, but the ants never worked in the earth, though they built a small wall with some sphagnum which had been introduced into the nest. Some larvae and cocoons of *F. fusca* were given to them, when they opened the latter and devoured the pupae, but accepted the former and covered them with bits of earth when ready to pupate.

He calls attention to the fact that Sahlberg[10] found a mixed colony of this species and *F. sanguinea* in Finland, which was living in a sphagnum nest.

Wasmann, in commenting on this, suggests that either a *sanguinea* female had been accepted into a colony of *picea* after her marriage-flight, or she had stolen some of their cocoons[37].

The latter author also considers that the *picea* workers covering the larvae with bits of earth is a case of atavism, as this ant in normal conditions would not possess earth for this purpose[37]—I have found, however, that ants in plaster nests where there is no earth present will use bits of plaster, cotton-wool, or anything they can get hold of for this purpose—and he points out that the white colour of these nests is caused by the fact that the sphagnum leaves possess large water-holding cells, between the green chlorophyl cells, and that when the leaves dry up the former cells fill with air, which gives a white appearance to the whole hillock[37].

Adlerz[38] says that *F. picea* appears to have completely adapted itself to a life in the sphagnum swamps of Nordland, outside of which he has never met with it, and he describes their nests as follows :—" In the sphagnum mounds inhabited by *F. picea* are passages and chambers dug out so compactly that their arrangement recalls that of the masonry nests of the species of *Lasius*. The excavated material is partly spread over the surface of the mound, thus increasing the size of the hillock, partly used for the partition walls between the chambers. These partitions are composed of a pliant, felted mass of shredded sphagnum interwoven and held together by a white, ramified fungus, which is of entirely different appearance to that of *Cladotrichum myrmecophilum* growing in nests of *Lasius fuliginosus*."

He says in fine weather the pupae are placed immediately under the outer covering of the chambers, and he has found the ants, their larvae, and pupae in the lower parts of the nest, which could be best compared to a completely saturated sponge, from which the water ran upon the slightest pressure ; and that if the hillocks be opened, the ants often seek refuge by plunging under the surface of the water, holding firmly on to the moss, swaying it, evidently of set purpose, and pressing it down into the water until it closes

over them, in order to hide in the already inundated chambers of the lower parts.

In his experience the pupae are as often naked as enclosed in cocoons, and if, as often asserted, the object of the cocoon is to protect the pupa against damp, then one would expect to find in these sphagnum nests, if anywhere, exclusively pupae in cocoons. Protection against dry weather appears to be unnecessary in these moss hillocks, so that the occurrence of cocoons among the *picea* pupae cannot be satisfactorily explained on these grounds.

Adlerz says that the males and winged females first appear at the beginning of August, and that he has found *picea* workers as slaves in *sanguinea* nests. He also found fly larvae (*Microdon*) in these nests.

On June 17th, 1914, I again visited Matley Bog in the hopes of finding nests of *F. picea* large enough to photograph for this work, but in this I was disappointed, though I was fortunate enough to find two incipient colonies of this most interesting species.

Search was first made in the spot where Crawley and I found the ant in 1912, but here it was all too dry, so proceeding further into the bog I at last found a few workers, running about, and foraging on a patch of wet sphagnum some distance away. Some were on grass stems and others running on the surface of the sphagnum carrying flies, the body of a small bee, etc., and often when a worker was alarmed it seemed to vanish, disappearing into the sphagnum.

On carefully tracking some of the workers carrying prey I eventually discovered two nests (the workers were found to hunt at considerable distances from their dwellings), the one covered with a low layer of cut sphagnum, the other almost without any covering, being situated in the sphagnum itself, and when I knelt down to dig up the nests the knees of my trousers were quickly soaked with water. The nests were situated about a foot below the surface, some worker pupae, in cocoons, and a few workers being at the top, and below, in the very wettest part, a queen, a number of larvae, some more pupae, callows, etc., occurred in each. The one colony consisted of about one hundred individuals, the other perhaps of twice as many, and evidently in both these cases a young queen had found a suitable spot, after the marriage-flight, and founded her colony alone.

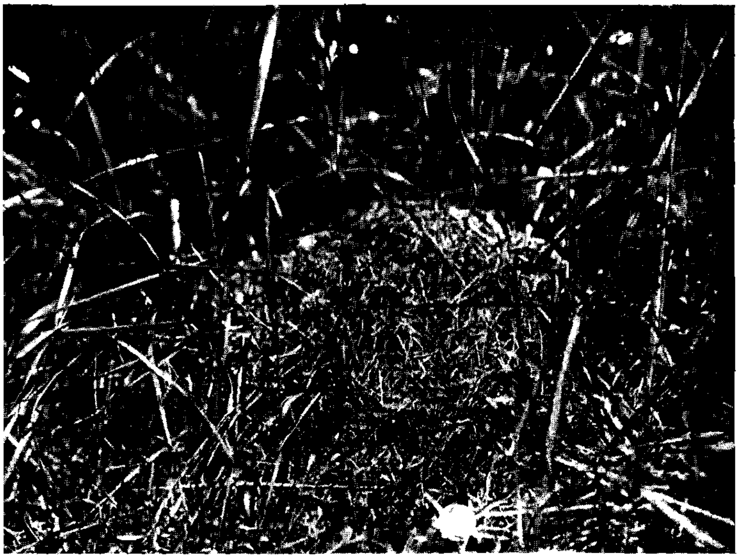
Piffard has since given to me a plan of the place where he and Arnold found their nest; it was not on my spot, nor the 1912 locality, so that evidently *F. picea* ranges all over Matley Bog, though this locality is not so favourable as those in Denmark and Sweden.

I dug up a large block of sphagnum about a foot deep, with the wet peaty earth attached and a little heather and grass growing in it, which I brought home and fixed up in a large glass bowl, with

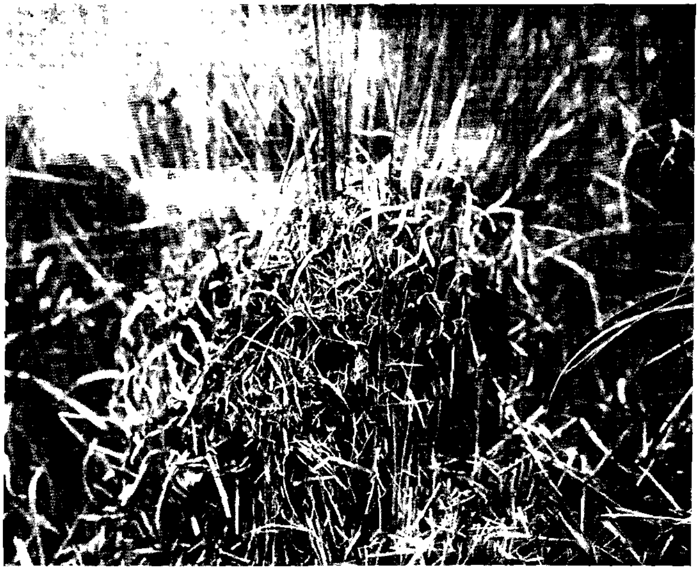
Nest of *Formica exsecta*. Parkhurst Forest, 29.VI.13.
(The white disc is a half-crown to show the size of the nest.)

Nest of *Formica picea*. Matley Bog, New Forest, 23.VII.14.

PLATE XVIII.



Nest of *Formica exsecta*. Parkhurst Forest. 29.VI.13.
(The white disc is a half-crown to show the size of the nest.)



Nest of *Formica picea*. Matley Bog, New Forest, 23.VII.14.

water at the bottom. I introduced one of the above-mentioned colonies of *picea* into this observation-nest. The queen and workers all disappeared into the sphagnum, carrying their brood. They soon established themselves in one corner of the clump, and now bits of sphagnum have been heaped above it. The ants feed on the honey which is placed in a lid fixed on the top of a pen-holder; dead flies, other ant-larvae, etc., when put into a small tray, are very soon removed, but only one or two of the workers come up to get the food.

On July 14th I captured a specimen of the aberrant Phorid *Aenigmatias blattoides* Mein., which had climbed up to the honey and fallen in, and a day or two before I saw a winged Phorid, very like *Platyphora lubbocki* Verrall, running about, which disappeared into the sphagnum. My later captures, mentioned presently, prove these to be the female and male of the same species.

On July 23rd when again in the New Forest further search for nests of *F. picea* proved successful, five colonies being found, which had constructed nests of various sizes. The smallest of these nests was only about three inches high, consisting of bits of cut grass built round the stem of a small shoot of "Bog Myrtle"; the largest was about a foot in height and six inches in diameter, consisting of fine cut grass, bits of heather, some leaves of "Bog Myrtle," and sphagnum, these materials being closely woven together, with no visible opening on the outside. The other three nests were chiefly composed of bits of sphagnum and were situated on patches of that material. The large nest, and two of the medium-sized ones, were dug up and carefully investigated; a single deälated female was found in each of the two latter nests, and three occurred in the former. Naked pupae, as well as cocoons, of both sexes and workers were present, very many large cocoons occurring in the big nest. In these nests I found a number of small Dipterous pupae, the "spring-tail" *Cyphodeirus albinos*, and some pink coccids of the genus *Pseudococcus*, new to science, which E. Green has named *P. sphagni*.

Three of the deälated females, a number of workers, larvae, and pupae were brought home and introduced into the glass bowl, when they all disappeared into the sphagnum, being quite friendly with the older inhabitants of the nest.

A number of the large cocoons with a few workers were placed in tins with a little damp earth and sphagnum, and males and winged females commenced to emerge on July 26th—eventually over thirty hatched; only six of these were females, the last of which appeared on October 15th, 1914.

A number of the Dipterous pupae hatched, proving to be *Platyphora* and *Aenigmatias*, which I have shown to be the male and female of *Platyphora lubbocki* Verrall.

On July 18th, 1918, I discovered a new locality for *picea*, further

in the bog at Matley, and here the ant was abundant. Over twenty nests were counted, fourteen occurring in the space of a few square yards, nearly every tussock among the sphagnum being occupied by them. Nearly all those examined contained two or more queens, the pupae in cocoons, larvae, and naked worker pupae, but in only one was a male seen. Every nest was inhabited by the Coccid *Pseudococcus sphagni*, which occurred loose in the galleries, and on roots of grass running through the nest, and the *picea* workers at once endeavoured to carry them into safety, when the nests were disturbed. The Coccid *Newsteadia floccosa* West., also occurred in several nests ; but male and female pupae of *Platyphora lubbocki* were found in nearly every one. These pupae were loose in the galleries and among the bits of cut grass and sphagnum of which the nests were mostly built[42].

On May 7th, 1922, workers of this ant were running about all over the " *picea* " area in Matley Bog. Several nests were located ; the colony from one of these, which contained no less than fifteen deälated females, was taken home and fitted up in a plaster nest. The ants were evidently not at home in the plaster nest and the colony did not thrive, though eggs were laid and larvae brought up. Amongst other food given to this nest was a number of *F. rufa* worker cocoons, some of which were cut open and the rufa pupae devoured ; others were allowed to hatch and the *rufa* workers lived for some time in this *picea* colony. Later on they were sometimes pulled about by the *picea* workers, and all eventually died[44].

On August 22nd, 1926, I found a colony of this ant inhabiting a tussock in Matley Bog, and on breaking it open a specimen of a *Gonatopus*, *G. oratorius* Westw., ran out of the nest.

COSMOPOLITAN AND INTRODUCED SPECIES.

Ants are continually being transported from land to land by commerce, in railway trains and ships, even the ships themselves becoming inhabited by some species.

Large numbers of ants, comprising single specimens, fecundated females, and even whole colonies, are carried about in fruit, vegetables, and plants of all kinds, sheltered in the leaves, earth, and moss adhering to the roots, etc.

Every botanical garden throughout the world receives annually numbers of species of ants from the tropics with orchids, etc., and by this means many of the species may become permanent inhabitants of the hot-houses ; through the exchange of plants some of the ant-fauna of one botanical garden may be introduced into another.

Forel, in a paper on the geographical distribution of the Formicidae, read at the Entomological Congress at Brussels, enumerated eleven species of ants which have become cosmopolitan, being introduced everywhere by shipping, viz. :—

1. *Odontomachus haematodes* L.
2. *Monomorium destructor* Jerdon.
3. *Monomorium floricola* Jerdon.
4. *Monomorium pharaonis* L.
5. *Solenopsis geminata* F.
6. *Pheidole megacephala* F.
7. *Tetramorium guineense* F.
8. *Tetramorium simillimum* F. Smith.
9. *Tapinoma melanocephalum* F.
10. *Prenolepis longicornis* Ltr.
11. *Prenolepis vividula* Nyl.

Of these all but the first, the third, and the fifth have been found in Britain, and some of them have become permanent inhabitants of hot-houses and dwellings.

Forel further gives four more species, which he says are actually becoming cosmopolitan at the present time, viz.:—

1. *Plagiolepis longipes* Jerdon.
2. *Triglyphothrix striatidens* Emery.
3. *Iridomyrmex humilis* Mayr.
4. *Cardiocondyla emeryi* Forel.

The second and third of these species have occurred with us.

I give a list of every species (as far as is known to me) which has been introduced into Britain. The majority of these have not established themselves, and many of them have only been found in the plants, etc., in which they had just reached this country, but it seems advisable to enumerate them all, as it shows how and when they were or might have been introduced, should they obtain a footing here.

PONERINAE.

Holcoponera striatula Mayr var. **obscura** Emery.

Ectatoma (Holcoponera) obscurum Emery Bull. Soc. Ent. Italiana **28** 48 (1896)[1]. *Ectatoma (Holcoponera) striatulum* v. *obscura* Forel Verh. Zool.-Bot. Ges. Wien **58** 341 (1908)[2]. *Holcoponera striatula* v. *obscura* Emery Gen. Ins. **58** 341 (1908)[3]; Crawley Ent. Rec. **37** 170 (1925)[4].

Habitat : Brazil, Para, Trinidad, etc.

Taken by H. Britten, junior, in a hot-house at York on August 19th, 1925[4].

Ectatomma regulare Mayr.

Gnamptogenys regularis Mayr Verh. Zool. Bot. Ges. Wien **20** 965 (1870)[1]. *Ectatomma regulare* Dalla Torre Cat. Hym. **7** 26 (1893)[2]. *Ectatomma (Gnamptogenys) regulare* Emery Gen. Ins. **118** 45 (1911)[3]. *Ectatomma regularis* Donisthorpe Bull. R. Bot. Gard. Kew **12** 368 (1911)[4].

Habitat : Mexico, Central America, Brazil.
Two workers captured in the propagating pits, Kew Gardens, in 1911[4].

Diacamma rugosum Le Guill. subsp. vagans F. Smith var. indica Forel.

Diacamma vagans Dalla Torre Cat. Hym. 7 29 (1893)[1] [in part]; Bingham Faun. Brit. Ind. Hym. 2 81 (1903)[2]. *Diacamma rugosum* race *vagans* var. *indicum* Forel Rev. Suisse Zool. 11 400 (1903)[3]. *Diacamma vagans* Bingham Bull. R. Bot. Gard. Kew (AS) 5 27 (1906)[4]. *Diacamma rugosum* subsp. *vagans* var. *indica* Emery Gen. Ins. 118 67 (1911)[5].

Habitat : India.
Captured in a case from Calcutta, Kew Gardens, June, 1898[4].

Neoponera theresiae Forel.

Pachycondyla theresiae Forel Biol. Centr. Amer. Hym. 3 13 (1899)[1]. *Neoponera theresiae* Emery Gen. Ins. 118 72 (1911)[2]; Lucas Pro. Ent. Soc. Lond. 1911 XVI[3].

Habitat : Peru and Panama.
Three workers on bananas at Swanage (*Tatchell*)[3].

Ponera coarctata Ltr. subsp. boerorum Forel.

Ponera coarctata r. *boerorum* Forel Rev. Suisse Zool. 9 339 (1901)[1]; Donisthorpe Bull. R. Bot. Gard. Kew 3 122 (1908)[2]. *Ponera* **punctatissima* subsp. *boerorum* Donisthorpe Trans. Leicester Lit.-Phil. Soc. 12 230 (1908)[3]: Ent. Rec. 23 14 (1911)[4]. *Ponera coarctata* subsp. *boerorum* Emery Gen. Ins. 118 90 (1911)[5].

Habitat : Natal.
Kew Gardens: Winged female in palm house, workers in fern house, January, 1908[2]; workers scarce in fern house, common in palm house under flower-pots, November, 1910[4]. Beresford sent me specimens to name from Dickson's nurseries, Newtownards, Co. Down.

Ponera opaciceps Mayr.

Ponera opaciceps Mayr Verh. Zool. Bot. Ges. Wien 37 536 (1887)[1]; Dalla Torre Cat. Hym. 7 40 (1893)[2]; Emery Gen. Ins. 118 92 (1911)[3]; Donisthorpe Bull. R. Bot. Gard. Kew 12 368 (1911)[4].

Habitat : Brazil, Uruguay, Mexico, Porto Rico, Texas.
Two workers in propagating pits, Kew Gardens, May, 1911[4].

Anochetus mayri Emery.

Anochetus mayri Emery Ann. Mus. Civ. Nat. Genova 21 378 (1884)[1]; Dalla Torre Cat. Hym. 7 48 (1893)[2]; Emery Gen. Ins. 118 110 (1911)[3].

Habitat : Antilles.

One worker under flower-pot in hot-house, Kew Gardens, 3.xi.11 (*Crawley*).

MYRMICINAE.

Pseudomyrma gracilis F.

Formica gracilis Fabricius Syst. Piez. 405 (1804)[1]. *Pseudomyrma gracilis* Dalla Torre Cat. Hym. 7 57 (1893)[2]; Emery Gen. Ins. **174** 29 (1921)[3].

Habitat : South and Central America.

Three workers, Kew Gardens, 20.iii.12.

Monomorium destructor Jerd.

Atta destructor Jerdon Madras Journ. Lit.-Sc. **17** 1851 105 (1853)[1]. *Monomorium destructor* Dalla Torre Cat. Hym. **7** 66 (1893)[2]; Forel Int. Ent. Cong. Bruxelles 1910 **2** 83 (1911)[3]; Donisthorpe Bull. R. Bot. Gard. Kew **12** 368 (1911)[4]. *Monomorium* (*Parholcomyrmex*) *destructor* Emery Gen. Ins. **174** 180 (1922)[5].

Habitat : Cosmopolitan species.

Living and dead workers in numbers on a plant from Calcutta; Kew Gardens, May, 1910[4].

Monomorium minutum Mayr.

Monomorium minutum Mayr Verh. Zool. Bot. Ver. Wien **5** 453 (1855)[1]; Er. André Spec. Hym. Europe **2** 333 (1881)[2]; Dalla Torre Cat. Hym. **7** 67 (1893)[3]. *Monomorium minutum minutum* Emery Deutsch. Ent. Zeitschr. **1908** 681[4]. *Monomorium minutum* Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 231 (1908)[5]: Bull. R. Bot. Gard. Kew **6** 251 (1909)[6]; Wheeler Journ. New York Ent. Soc. **17** 183 (1909)[7]. *Monomorium* (*Monomorium*) *minutum* Emery Gen. Ins. **174** 172 (1922)[8].

Habitat : Italy, Corfu, Syria, Algeria.

Kew Gardens : On a plant from the Cambridge Botanic Gardens in 1908[5], and in fern pits, February, 1909[6].

Monomorium pharaonis L.

Cosmopolitan species (see p. 103).

Pheidologeton diversus Jerd.

Ocodoma diversa Jerdon Madras Journ. Lit.-Sc. **17** 1851 109 (1853)[1]. *Pheidologeton diversus* Dalla Torre Cat. Hym. **7** 73 (1893)[2]. †*Phidologiton diversus* Bingham Faun. Brit. Ind. Hym. **2** 162 (1903)[3]. *Pheidologeton diversus* Donisthorpe Bull. R. Bot. Gard. Kew **12** 368 (1911)[4]; Emery Gen. Ins. **174** 212 (1922)[5].

Habitat : India, Burma, extending into Malayan sub-region.

A deälated female and small workers in fern pits (the large queen was in the soil at the bottom of a flower-pot), Kew Gardens, November, 1909[4].

Cremastogaster scutellaris Ol.

Formica scutellaris Olivier Enc. Méth. Ins. 6 497 (1791)[1]. *Cremastogaster scutellaris* Forel Denkschr. Schweiz Ges. Naturw. **26** 68 223 386 (1874)[2]; Er. André Spec. Hym. Europe 2 392 (1881)[3]; Billups Proc. Ent. Soc. Lond. **1884** XIV[4]; Mason Proc. Ent. Soc. Lond. **1889** XXII[5]; Dalla Torre Cat. Hym. 7 85 (1893)[6]; Saunders Hym.-Acul. 42 (1896)[7]; Bingham Bull. R. Bot. Gard. Kew (AS) 5 28 (1906)[8]; Vic. Hist. Cornwall 1 182 (1906)[9]; Vic. Hist. Devon 1 188 (1906)[10]; Vic. Hist. Stafford 1 83 (1908)[11]; Donisthorpe Trans. Leicester Lit.-Phil. Soc. 12 231 (1908)[12]: Bull. R. Bot. Gard. Kew **6** 251 (1909)[13]. *Crematogaster scutellaris scutellaris* Emery Deutsch. Ent. Zeitschr. 1912 653[14]. *Crematogaster* (*Acrocoelia*) *scutellaris* Emery Gen. Ins. **174** 143 (1922)[15].

Habitat : Europe, south-west, Mediterranean, etc.; North Africa, Tunisie, etc.

This ant has frequently been taken in England, being often imported in virgin cork; Billups captured workers running on the pavement in Church Street, Greenwich, near the premises of a firm of cork importers[4]; it occurred in abundance in the fernery of Mr. Baxter at Burton-on-Trent[5]; Bingham records it amongst virgin cork at Kew Gardens[8]; it occurred in greenhouses at Penryn, Cornwall[9]; in imported apples on November 1st, 1892, in Devonshire[10]; and in June of the same year E. A. Butler observed it in some numbers on virgin cork in a shop in North London[12]. In April, 1909, I found it in abundance, in company with *Colobopsis truncata* Spin., in cork at Kew Gardens[13]; and Pool sent me specimens of these two species which he had captured in the insect house in the Zoological Gardens in July, 1914.

Cremastogaster terminalis Shuck.

Myrmica terminalis Shuckard Mag. Nat. Hist. (n.s.) 2 627 (1838)[1]. *Cremastogaster terminalis* Dalla Torre Cat. Hym. 7 87 (1893)[2]. *Crematogaster terminalis* Emery Gen. Ins. **174** 158 (1922)[3].

Taken by Abel Ingpen in hot-houses in Chelsea.[1]

Cremastogaster lineolata Say.

Myrmica lineolata Say Boston Journ. NH. **1** 290 (1836)[1]. *Myrmica* (*Monomorium*) *lineolata* F. Smith Cat. Hym. Brit. Mus. **6** 129 (1858)[2]. *Atta lineolata* Mayr Verh. Zool. Bot. Ges. Wien **13** 396 (1863)[3]. *Cremastogaster lineolata* Mayr Verh. Zool. Bot. Ges. Wien **16** 901 (1866)[4]; Wheeler Ants 564 (1910)[5]. *Crematogaster* (*Acrocoelia*) *lineolata* Emery Gen. Ins. **174** 141 (1922)[6]. *Cremastogaster lineolata* Donisthorpe Ent. Rec. 38 19 (1926)[7].

Habitat : United States[6]; North America, and Canada[5].

Saunt sent me a number of workers of this ant, which had been taken on American ash in a timber yard at Coventry on April 28th, 1925[7].

Pheidole gertrudae Forel.

Pheidole gertrudae Forel Ann. Soc. Ent. Belg. **30** XLII (1886)[1]; Dalla Torre Cat. Hym. **7** 90 (1893)[2]; Donisthorpe Bull. R. Bot. Gard. Kew **12** 368 (1911)[3]. *Pheidole* (*Pheidole*) *gertrudae* Emery Gen. Ins. **174** 101 (1922)[4].

Habitat : Brazil ; Rio de Janeiro.

A winged female, numerous soldiers, and workers taken in propagating pits in Kew Gardens, May, 1911[3].

Pheidole megacephala F.

Formica megacephala Fabricius Ent. Syst. **2** 361 (1793)[1]. *Oecophthora pusilla* Heer Zurcher. Jung. Naturf. Ges. **54** 1–24 (1852)[2]. *Myrmica* (?) *laevigata* F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 130 (1855)[3]. *Oecophthora pusilla* Heer (trans. Lowe) Ann. Mag. Nat. Hist. (n.s.) **17** 209–224 322–333 Pf. III 1–4 (1856)[4]. *Myrmica* (*Pheidole*) *pallidula* F. Smith Trans. Ent. Soc. Lond. (n.s.) **4** 1857 282 (1858)[5]. *Myrmica* (*Pheidole*) *laevigata* F. Smith Cat. Brit. Foss. Hym. 35 225 (1858)[6] : Ent. Ann. **1862** 70 Pf. [1] 4 7–8[7]. *Pheidole laevigata* F. Smith Ent. Mo. Mag. **2** 29 (1865)[8] : Ent. Ann. **1871** 61[9]. *Pheidole pusilla* Blackburn and Kirby Ent. Mo. Mag. **17** 89 (1880)[10]. *Pheidole pallidula* Parfitt Trans. Devon Assn. Sc.-Lit. **12** 517 (1880)[11]. *Pheidole megacephala* Saunders Trans. Ent. Soc. Lond. **1880** 223[12] ; Er. André Spec. Hym. Europe **2** 383 (1881)[13]; Dalla Torre Cat. Hym. **7** 92 (1893)[14]. *Pheidole laevigata* Farren-White Ants' Ways 60 248 (1895)[15]. *Pheidole megacephala* Saunders Hym.-Acul. 42 (1896)[16] ; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 230 (1908)[17] ; Forel Int. Ent. Cong. Bruxelles 1910 **2** 83 (1911)[18] ; Emery Rev. Zool. Africane **4** 223 (1915)[19]. *Pheidole* (*Pheidole*) *megacephala* Emery Gen. Ins. **174** 85 (1922)[20].

Habitat : Cosmopolitan species.

This species was known as the house-ant of Madeira, where it was very abundant, and Heer wrote a very interesting paper on its habits[2]. F. Smith records, in 1855, that this ant occurred some years ago at Battersea[3] ; in 1858, its capture on a wall at Hampstead, and in a hot-house at Exeter (*Parfitt*)[5] ; and in 1862 he states it has been found in many conservatories, and in numbers in a baker's shop in the Borough (*Farren-White*)[7]. Parfitt records its occurrence in numbers in Mr. Veitch's nursery at Exeter[11], Saunders at Greenwich[12], and Farren-White in an eating-house in the City as well as in the baker's shop in the Borough ; he says it is undoubtedly naturalized[15]. Rothney, when writing to me in 1917, told me that it was formerly established at 65 Old Bailey, E.C. Fryer sent me a soldier and workers in February, 1916, from a hot-house at St. Albans.

Pheidole megacephala F. var. punctulata Mayr.

Pheidole punctulata Mayr Verh. Zool. Bot. Ges. Wien **16** 899 (1866)[1] ; Dalla Torre Cat. Hym. **7** 95 (1893)[2]. *Pheidole megacephala punctulata* Emery Rev. Zool. Africane **4** 225 (1915)[3]. *Pheidole* (*Pheidole*) *megacephala* subsp.

punctulata Emery Gen. Ins. **174** 85 (1922)[4]. *Pheidole megacephala* v. *punctulata* Donisthorpe Ent. Rec. **38** 19 (1926)[5].

Habitat : South Africa ; Sierra Leone.

In February, 1913, Purser sent me workers and soldiers of this variety to name, which he had taken in the Cambridge Botanic Gardens. He tells me they attend "scales" and "mealy bugs," and build earthen chambers round the stems of small plants in flower-pots, up to about an inch above the soil. In January, 1914, Scott sent me more workers and males from the same locality ; he says the ants have evidently been established for some time. Saunt sent me soldiers and workers, taken in a timber yard at Coventry on August 12th, 1925[3].

Pheidole anastasii Emery var. cellarum Forel.

Pheidole anastasii Viehmeyer Naturwis. Gesells Isis. in Dresden **1906** 68[1], *Pheidole anastasii* v. *cellarum* Forel Bull. Soc. Vaud. Sc. Nat. **44** 55 (1908)[2] ; Donisthorpe Bull. R. Bot. Gard. Kew **3** 122 (1908)[3] : Trans. Leicester Lit.-Phil. Soc. **12** 231 (1908)[4] ; Bondroit Ann. Soc. Ent. Belg. **55** 14 (1911)[5]. *Pheidole anastasi*† v. *cellarum* Santschi Bull. Soc. Vaud. Sci. Nat. **53** 164 (1920)[6]. *Pheidole* (*Pheidole*) *anastasii* v. *cellarum* Emery Gen. Ins. **174** 107 (1922)[7].

Habitat : Guatemala (?) ; Costa Rica. (?)

Forel described this variety from specimens taken in hot-houses at Kew, Zurich, and Dresden[2].

In February, 1908, workers and soldiers were very abundant in the orchid house in Kew Gardens[3], and again in 1913. In June, 1914, Cooper gave me specimens to name which he had captured in a hot-house at Bournemouth. Hamm has sent it to me from a hot-house, where it is abundant, near Oxford. Beresford has taken it in Dickson's nurseries, Newtownards, Co. Down ; Britten at Knowsley, Lancashire ; and Halkyard at Broadbottom, Cheshire. Viehmeyer recorded that this form had inhabited the hot-houses in the Botanic Gardens at Dresden for a number of years. He says they eagerly attended plant lice and scale insects, and also sought the extra floral nectaries of *Cattleya labiata*[1].

Bondroit found it in abundance in the hot-houses in the Botanic Gardens at Brussels[5].

Santschi records *cellarum* as being very abundant in the orchid houses in the Botanic Gardens at Zurich, where he points out it had exterminated and replaced the other ants which formerly inhabited these houses[6].

Forel wrote to me (27.xi.13) as follows :—"This form is so typical in all hot-houses in Europe, that it has almost become a race."

Pheidole rhombinoda Mayr.

Pheidole rhombinoda Mayr Verh. Zool. Bot. Ges. Wien **28** 678 (1878)[1] ; Dalla Torre Cat. Hym. **7** 95 (1893)[2] ; Bingham Faun. Brit. Ind. Hym. **2** 250 (1903)[3]. *Pheidole* (*Pheidole*) *rhombinoda* Emery Gen. Ins. **174** 93 (1921)[4].

Habitat : India ; Ceylon.

A deälated female, soldiers, and workers, Kew Gardens, September, 1912.

Cardiocondyla britteni Crawley.

Cardiocondyla britteni Crawley Ent. Rec. **32** 180 (1920)[1].

Habitat : Tropical America. (?)

A single worker was taken by H. Britten among butter beans, at West Didsbury, on May 12th, 1919[1].

Tetramorium guineense F.

Formica guineensis Fabricius Ent. Syst. **2** 357 (1793)[1]. *Tetramorium kollari* Mayr Verh. Zool. Bot. Ver. Wien **5** 425 (1855)[2]. *Myrmica reticulata* F. Smith Trans. Ent. Soc. Lond. (3 S) **1** 33 (1862)[3] : Ent. Ann. **1871** 60[4]. *Myrmica kollari* F. Smith Ent. Ann. **1871** 60[5]. *Leptothorax reticulata* Parfitt Trans. Devon Assn. Sc.-Lit. 12 516 (1880)[6]. *Tetramorium guineense* Saunders Trans. Ent. Soc. Lond. **1880** 223[7] ; Er. André Spec. Hym. Europe **2** 288 (1881)[8] ; Dalla Torre Cat. Hym. **7** 133 (1893)[9]. *Tetramorium kollari* Farren-White Ants' Ways 242 (1895)[10]. *Tetramorium guineense* Saunders Hym.-Acul. 34 (1896)[11] ; Thornley Nat. **1898** 13[12] ; Vic. Hist. Notts **1** 91 (1906)[13] ; Godfrey Notes R. Bot. Gard. Edinburgh **17** 101 (1907)[14] ; Donisthorpe Trans. Leicester Lit.-Phil. Soc. 12 230 (1908)[15] ; Emery Deutsch. Ent. Zeitschr. **1909** 695[16] ; Donisthorpe Bull. R. Bot. Gard. Kew **12** 368 (1911)[17] : Ent. Rec. **23** 14 (1911)[18] ; Forel Int. Ent. Cong. Bruxelles 1910 **2** 83 (1911)[19] ; Emery Gen. Ins. **174** 278 (1922)[20] ; Wheeler NH. Juan Fernandez and Easter Island **3** 318 (1922)[21] : Psyche **31** 136 (1924)[22] : Zoologica **5** 109 (1924)[23].

Habitat : Cosmopolitan species.

F. Smith records this species, in 1862, from the Botanic Gardens at Exeter (*Parfitt*)[3], and subsequently from Sheerness taken in 1866 (*Brewer*)[5]. Saunders gives Exeter and Greenwich as localities[7] ; and Farren-White found it in great numbers in a hot-house at Stroud, and at Easting near Stonehouse, and in 1894 he captured it in the Botanic Gardens in Regent's Park[10]. Pegler took a worker at Retford, Notts[12] ; and Godfrey describes it as the most abundant species in the Botanic Gardens at Edinburgh, winged specimens occurring from June to September[14]. Crawley observed this species in a conservatory at West Leake, Notts, in 1909, where he says it had been abundant for some years[18]. In December, 1910, it occurred in some numbers in a small hot-house in Kew Gardens, deälated females walking about freely among the workers[17]. In 1911 E. A. Butler captured specimens in a hot-house at Harrow. J. F. X. King took specimens in the Botanic Gardens at Belfast, and Halbert sent me specimens to examine from the Buckle Collection, also from Belfast—these were standing under the name *Myrmica lippula.* In the British Museum Collection specimens taken by R. S. Draper in hot-houses in Sunderland were doing duty for *Myrmica lobicornis.*

In January, 1916, Fryer sent it to me to name, taken in glass-houses at Turnford (between Cheshunt and Broxborn) ; and Butter-

field, from an orchid house at Heaton in Yorkshire. Halkyard has found it at Broadbottom in Cheshire, and Lawson at Hale in the same county.

Wheeler records it from the Galapagos[23] and from Easter Island[21]; and in 1924 he described an interesting gynandromorph of this species—the head being male, the remainder of the body female—taken on Necker Island, north-west of Honolulu. This made the 48th gynandromorph described to date.

Tetramorium simillimum F. Smith.

Myrmica simillima F. Smith List. Brit. Anim. Brit. Mus. Acul. 118 (1851)[1]; Curtis Trans. Linn. Soc. Lond. 21 216 (1854)[2]; F. Smith Trans. Ent. Soc. Lond. (n.s.) 3 129 (1855)[3]: Ent. Ann. **1855** 98[4]. *Myrmica* (*Leptothorax*) *simillima* F. Smith Cat. Brit. Foss. Hym. 31 (1858)[5]. *Leptothorax simillima* Parfitt Trans. Devon Assn. Sc.-Lit. **12** 517 (1880)[6]. *Tetramorium simillimum* Saunders Trans. Ent. Soc. Lond. **1880** 223[7]; Er. André Spec. Hym. Europe **2** 287 (1881)[8]; Dalla Torre Cat. Hym. **7** 134 (1893)[9]. *Leptothorax simillimus* Farren-White Ants' Ways 245 (1895)[10]. *Tetramorium simillimum* Saunders Hym.-Acul. **34** (1896)[11]; Vic. Hist. Devon **1** 188 (1906)[12]; Donisthorpe Bull. R. Bot. Gard. Kew **3** 122 (1908)[13]: Trans. Leicester Lit.-Phil. Soc. **12** 230 (1908)[14]; Emery Deutsch. Ent. Zeitschr. **1909** 696[15]; Forel Int. Ent. Cong. Bruxelles 1910 **2** 83 (1911)[16]; Emery Gen. Ins. **174** 279 (1922)[17]; Wheeler NH. Juan Fernandez and Easter Island **3** 344 (1922)[18]; Emery Bull. Soc. Ent. Italiana **56** 8 (1924)[19].

Habitat: Cosmopolitan species.

F. Smith recorded that this ant was taken by Dale near his house at Glanvilles Wootton in Dorsetshire[3], but subsequently that it had occurred in a greenhouse[5]. Parfitt observed it in large numbers, in June, 1876, in a hot-house at Exeter[6]; Saunders recorded it from Kew in 1880[7]; and Farren-White discovered it in a hot-house at Cheltenham[10]. In January and February, 1908, I found it present in some numbers in the palm house at Kew Gardens[13]; a few deälated females were taken walking amongst the workers. Britten, junior, took it at Crank, Lancashire, in 1919. Emery points out that it has been introduced into Bengasi, Cirenaica[19]; and Wheeler records it from Easter Island[18].

Tetramorium magitae Forel.

Tetramorium magitae Forel in Escherich Termiten. Ceylon 224 (1911)[1]; Donisthorpe Bull. R. Bot. Gard. Kew 12 368 (1911)[2]; Emery Gen. Ins. **174** 284 (1922)[3].

Habitat: Ceylon.

A number of workers on a plant from Java, Kew Gardens, January, 1911[2].

Tetramorium lucayanum Wheeler var. sexdens Forel.

Tetramorium lucayanum var. *sexdens* Forel Bull. Soc. Vaud. Sci. Nat. **50** 357 (1915)[1]; Emery Gen. Ins. **174** 284 (1922)[2].

Beresford sent me specimens of a *Tetramorium* to name which he had taken in the Glasnevin Botanic Gardens, Co. Dublin. Forel told me it was a new variety of a species recently described by Wheeler from the Bahamas.

Wasmannia auro-punctata Rog.

Tetramorium (?) *auro-punctatum* Roger Berlin Ent. Zeits. **7** 182 (1863)[1]. *Tetramorium auro-punctatum* Dalla Torre Cat. Hym. **7** 130 (1893)[2]. *Wasmannia auro-punctata* Forel Trans. Ent. Soc. Lond. **1893** 383[3]; Donisthorpe Bull. R. Bot. Gard. Kew **3** 122 ((1908)[4]: Trans. Leicester Lit.-Phil. Soc. **12** 230 (1908)[5]: Bull. R. Bot. Gard. Kew **6** 251 Pf. [1]·7 (1909)[6]: **12** 368 (1911)[7]; Emery Gen. Ins. **174** 294 (1922)[8].

Habitat : West Indies.

I first discovered this very small species in Kew Gardens in 1907[4]; it is one of the commonest ants at Kew, being abundant in the propagating pits and some other houses. It nests in and under flower-pots, in the leaf-sheaves of *Piper obliquum* v. *eximium*, etc., and its males and females, which are very large in comparison with the workers, occur in December and January in the nests, and sometimes on the walls of the hot-houses. A small " wood-louse " somewhat like *Platyarthrus hoffmanseggi*, and the little spider *Diblemma donisthorpei* Camb., which is superficially very like the worker ants, are usually to be found in the nests. In 1922 Halkyard took it in a banana store in Manchester.

Triglyphothrix striatidens Emery.

Tetramorium obesum razza *striatidens* Emery Ann. Mus. Civ. Gen. **27** 501 (1889)[1]. *Triglyphothrix striatidens* Dalla Torre Cat. Hym. **7** 136 (1893)[2]; Bingham Faun. Brit. Ind. Hym. **2** 173 (1903)[3]. *Triglyphothrix obesa* st. †*striatideus* Bingham Bull. R. Bot. Gard. Kew (AS) **5** 28 (1906)[4]. *Triglyphothrix striatidens* Donisthorpe Bull. R. Bot. Gard. Kew **3** 122 (1908)[5]: Trans. Leicester Lit.-Phil. Soc. **12** 231 (1908)[6]; Forel Int. Ent. Cong. Bruxelles 1910 **2** 83 (1911)[7]; Wheeler Journ. Econ. Entom. **9** 566 (1916)[8]: Iowa Stud. NH. **10** 5 (1918)[9]; Emery Gen. Ins. **174** 274 (1922)[10]; Wheeler Rec. India Mus. **36** 123 (1924)[11].

Habitat : India, Burma, Ceylon, Tunis, Sierra Leone, etc.

Bingham records this ant in the propagating pits[4], and I have found it in plenty in the fern and palm houses in Kew Gardens[5].

Wheeler records it from Louisiana[8], U.S.A., and from Barbados[9], where he says it has been recently imported from the Old World tropics; and a winged female and several workers, taken by S. Kemp in the Siju Cave, Garo Hills, Assam, nesting in complete darkness, 400 feet from the entrance of the cave, under stones in ground heavily manured with bat-guano.

Strumigenys rogeri Emery.

Strumigenys rogeri Emery Bull. Soc. Ent. Ital. **22** 68 (1890)[1]; Dalla Torre Cat. Hym. **7** 147 (1893)[2]; *Strumigenys* incisa* Godfrey Notes R. Bot. Gard.

dinburgh, **17** 102 (1907)[3]. *Strumigenys rogeri* Donisthorpe Bull. R. Bot. ard. Kew **3** 122 (1908)[4]: Trans. Leicester Lit.-Phil. Soc. **12** 231 (1908)[5]: ıll. R. Bot. Gard. Kew **6** 251 Pf. [1]·9 (1909)[6]. *Strumigenys* (*Strumigenys*) *geri* Emery Gen. Ins. **174** 322 (1922)[7].

Habitat: West Indies.

Several workers were taken in the propagating pits in 1904 *Godfrey*) and again in 1905 (*Stewart*), Edinburgh Botanic Gardens[3]. here is a winged female from the same source in the British ıuseum Collection.

I captured a few workers under flower-pots in the propagating ıts, Kew Gardens, December, 1907[4 5], and a few have occurred nce.

DOLICHODERINAE.

Iridomyrmex humilis Mayr.

Hypoclinea humilis Mayr Ann. Soc. Nat. Modena **3** 164 (1868)[1]. *Iri-ımyrmex humilis* Dalla Torre Cat. Hym. **7** 169 (1893)[2]; Carpenter Econ. roc. R. Dublin Soc. **1** 155 (1902)[3]; Donisthorpe Trans. Leicester Lit.-Phil. ıc. **12** 229 (1908)[4]; Foster Journ. Econ. Ent. **1** 289–293 (1908)[5]; Wood-orth Univ. Cal. Agri. Exp. Stn. Circ. **38** 1–11 (1908)[6]; Newell Journ. Econ. nt. **2** 174–192 (1909)[7]; Wheeler Ants 153–155 (1910)[8]; Forel Int. Ent. ıng. Bruxelles 1910 **2** 83 (1911)[9]; Emery Gen. Ins. **137** 26 (1912)[10]; Arnold nn. S. African Mus. **14** 144 (1915)[11]; Donisthorpe Ent. Rec. **28** 4 (1916)[12]; 'asmann Ent. Mitt. **6** 184–186 (1917)[13]; Donisthorpe Ent. Rec. **33** 60 921)[14]: **35** 3 (1923)[15].

Habitat: Argentine; Brazil.

This species is known as the " Argentine Ant "; it is rapidly be-ıming cosmopolitan, and when once introduced into a new locality may become a very serious pest. It displaces local species, and ıems to have entirely exterminated *Pheidole megacephala* in ıadeira[8]. It has been introduced into New Orleans[5] and Cali-ırnia[6]; in the former locality it now extends over fully five ıousand square miles—from New Orleans to the Gulf of Mexico.

Wasmann points out how it has spread in Cape Colony and over-helmed the natural ant fauna[13]; and Arnold says it was probably ıtroduced in forage during the Boer War, and is common all over ıe Cape Peninsula, being a great pest in houses in the neighbour-ıod of Cape Town. It has been recorded as far east as Maseru in asutoland[11]. It has been recorded in Europe from Hamburg and ıe centre of France[14]; Tomlin took it in Guernsey; and I have cently discovered it at Palermo in Sicily.

Newell has written an interesting account of the life-history of ıis species[7].

Carpenter records its occurrence in vast numbers in a house in 'indsor Park, Belfast, in 1900, where it had been observed for ghteen months. The ants were present in the laundry, con-rvatory, and vinery, crossing the kitchen yard in great abundance.

The ants were only got rid of with the greatest difficulty; the floors were taken up and eight large nests were found at a depth of three to four feet; they were also present in the walls. Waterston in 1912 sent me specimens of this ant to name, taken in the Botanic Gardens in Edinburgh.

In November, 1915, it was sent to me to name from Eastbourne[12]; where I understand a number of houses have been practically rendered uninhabitable by it. Fryer has sent me specimens from Enfield[15], and Keys from houses in Plymouth[15]. In 1921 Halkyard took it in a hot-house at Broadbottom, Cheshire; in 1922 Britten, junior, captured workers in Canary bananas at Fallowfield, Manchester; and in 1926 I found it at Tring.

Tapinoma melanocephalum F.

Formica melanocephala Fabricius Ent. Syst. 2 353 (1793)[1]. *Tapinoma melanocephalus* Billups Proc. Ent. Soc. Lond. **1887** XXVII[2]. *Tapinoma melanocephalum* Dalla Torre Cat. Hym. 7 165 (1893)[3]; Godfrey Notes R. Bot. Gard. Edinburgh **17** 102 (1907)[4]; Forel Int. Ent. Cong. Bruxelles 1910 **2** 83 (1911); Emery Gen. Ins. **137** 41 (1912).

Habitat: Cosmopolitan species.

Billups captured this ant in September, 1886, on a palm in the palm house in Kew Gardens[2]; Godfrey records finding a nest in a pot containing an orchid from Hamburg, in June, 1904, in the Edinburgh Botanic Gardens, where the species was again found in August, 1904, and February, 1905 (*Stewart*)[4]. Hamm took it in some numbers on November 30th, 1908, on fruit in the Oxford market. In 1922 Halkyard captured workers in a banana store in Manchester.

Tapinoma minutum Mayr.

Tapinoma minutum Mayr Verh. Zool. Bot. Ges. Wien **12** 703 (1862)[1]; Dalla Torre Cat. Hym. 7 166 (1893)[2]. *Tapinoma *melanocephalum* Donisthorpe Bull. R. Bot. Gard. Kew **12** 368 (1911)[3]. *Tapinoma minutum* Emery Gen. Ins. **137** 41 (1912)[4].

Habitat: New South Wales.

Workers in some numbers, Kew Gardens, 1911[3].

Technomyrmex albipes F. Smith.

Formica (*Tapinoma*) *albipes* F. Smith Journ. Pro. Linn. Soc. Zool. **6** 38 (1862)[1]. *Technomyrmex albipes* Dalla Torre Cat. Hym. 7 166 (1893)[2]; Bingham Faun. Brit. Ind. Hym. **2** 301 (1903)[3]: Bull. R. Bot. Gard. Kew (AS) **5** 28 (1906)[4]; Donisthorpe Bull. R. Bot. Gard. Kew **3** 122 (1908)[5]: Trans. Leicester Lit.-Phil. Soc. **12** 229 (1908)[6]; Forel Bull. Soc. Vaud. Sc. Nat. **44** 21 (1908)[7]; Donisthorpe Bull. R. Bot. Gard. Kew **6** 251 Pf. [1]-4 8 (1909)[8]: **12** 368 (1911)[9]: Ent. Rec. **23** 15 (1911)[10]; Emery Gen. Ins. **137** 43 (1912)[11].

Habitat: India, Malay Isles, New Guinea, etc.

Bingham records this species from the palm house at Kew[4]; it is the commonest ant in the hot-houses in Kew Gardens, occurring

in abundance in the fern and palm houses, propagating pits, and other hot and some cooler houses. In 1908 I discovered an apterous form of the male, which Forel has described[7], and is sometimes abundant in company with the winged form. In 1910 I found a short-winged male which I have suggested may be a mermithaner[10]. I never took the winged female, but on February 11th, 1909, I captured a deälated female walking on a rockery in the palm house.

I have received this ant from the Dublin Botanic Gardens (*Halbert*), and the Edinburgh Botanic Gardens (*Bagnall*).

Technomyrmex albipes F. Smith var. **brunneipes** Forel.

Technomyrmex albipes v. *brunneipes* Forel Journ. Bombay NH. Soc. **9** 466 (1895)[1]; Bingham Faun. Brit. Ind. Hym. **2** 302 (1903)[2]; Godfrey Notes R. Bot. Gard. Edinburgh **17** 101 (1907)[3]; Emery Gen. Ins. **137** 43 (1912)[4].

Habitat : India.

Godfrey records this variety from the Botanic Gardens at Edinburgh ; according to Stewart it builds earthen chambers[3].

FORMICINAE.

Plagiolepis alluaudi Emery.

Plagiolepis flavidula Er. André Spec. Hym. Europe **2** 208 (1881)[1]; Dalla Torre Cat. Hym. **7** 172 (1893)[2]. *Plagiolepis alluaudi* Emery Ann. Soc. Ent. France **1894** 71[3]. *Plagiolepis flavidula* Saunders Hym.-Acul. 26 (1896)[4]; Vic. Hist. Warwick **1** 73 (1904)[5]; Vic. Hist. Notts **1** 91 (1906)[6]. *Plagiolepis alluaudi* Donisthorpe Bull. R. Bot. Gard. Kew **3** 122 (1908)[7]: Trans. Leicester Lit.-Phil. Soc. **12** 229 (1908)[8]; Emery Ann. Soc. Ent. Belg. **61** 318 (1921)[9]. *Plagiolepis (Plagiolepis) alluaudi* Emery Gen. Ins. **183** 19 (1925)[10].

Habitat : Seychelles.

This little species has been found in the Botanic Gardens at Kew[4], Cambridge[4], Edgbaston[5], Dublin (*Halbert*)[8], Edinburgh (*Bagnall*)[8], Oxford (*Hamm*), and Belfast (*J. F. X. King*) ; in greenhouses at Bramcote, Notts[6], and Beccles, Suffolk (*Crowfoot*). I found it in abundance in the palm house at Kew in December, 1907[7], Hamm captured winged females at Oxford on April 11th, 1903, and Hodson took specimens in a conservatory at Grantham in 1922.

√ **Plagiolepis exigua** Forel.

Plagiolepis exigua Forel Journ. Bombay NH. Soc. **8** 417 (1894)[1]; Bingham Faun. Brit. Ind. Hym. **2** 323 (1903)[2]; Godfrey Notes R. Bot. Gard. Edinburgh **17** 102 (1907)[3]; Emery Ann. Soc. Ent. Belg. **61** 317 (1921)[4]. *Plagiolepis (Plagiolepis) exigua* Emery Gen. Ins. **183** 20 (1925)[5].

Habitat : India.

Godfrey records this species as abundant in the hot-houses at

Edinburgh in 1904 ; nests were found in 1905, in the aroid house, in hollow metal rods[3].

Brachymyrmex (Brachymyrmex) heeri Forel var. aphidicola Forel.

Brachymyrmex heeri v. *aphidicola* Forel Deutsch. Ent. Zeitschr. **1909** 263[1]. *Brachymyrmex* (*Brachymyrmex*) *heeri* v. *aphidicola* Emery Gen. Ins. **183** 42 (1925)[2]. *Brachymyrmex heeri* v. *aphidicola* Crawley Ent. Rec. **37** 170 (1925)[3].

Habitat : Paraguay, Brazil.

Taken by H. Britten, junior, in a hot-house at York on October 17th, 1925[3].

Brachymyrmex (Brachymyrmex) patagonicus Mayr.

Brachymyrmex patagonicus Mayr Ann. Soc. Nat. Modena **3** 164 (1868)[1] ; Dalla Torre Cat. Hym. **7** 174 (1893)[2] ; Donisthorpe Bull. R. Bot. Gard. Kew **6** 251 (1909)[3]. *Brachymyrmex* (*Brachymyrmex*) *patagonicus* Emery Gen. Ins. **183** 42 (1925)[4].

Habitat : Central America.

This species occurred in abundance in the orchid house at Kew in 1909[3], and again in 1910.

Prenolepis nitens Mayr.

Tapinoma nitens Mayr Ver. Zool. Bot. Ver. Wien **2** 144 (1852)[1]. *Tapinoma polita* F. Smith Trans. Ent. Soc. Lond. (n.s.) **3** 112 (1855)[2] : Cat. Brit. Foss. Hym. 18 (1858)[3] : Ent. Mo. Mag. **2** 29 (1865)[4] *Tapinoma nitens* Saunders Trans. Ent. Soc. **1880** 211[5]. *Tapinoma polita* Dale Ent. Mo. Mag. **17** 236 (1881)[6]. *Prenolepis nitens* Er. André Spec. Hym. Europe **2** 204 (1881)[7]. *Tapinoma nitens* Saunders Ent. Mo. Mag. **20** 270 (1884)[8]. *Prenolepis imparis* var. *nitens* Dalla Torre Cat. Hym. **7** 178 (1893)[9]. *Tapinoma polita* Farren-White Ants' Ways 237 (1895)[10]. *Prenolepis nitens* Saunders Hym.-Aeul. 25 (1896)[11] ; Bingham Bull. R. Bot. Gard. Kew (AS) **5** 28 (1906)[12] ; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 228 (1908)[13]. *Prenolepis imparis* subsp. *nitens* Emery Deutsch. Ent. Zeitschr. **1910** 128[14]. *Prenolepis nitens* Emery Bull. Soc. Ent. Italiana **47** 238 (1916)[15] ; Finzi Bull. Soc. Ent. Italiana **53** 3 (1921)[16] ; Blöte Nederland Ent. Ver. **1924** XVI[17] ; Emery Gen. Ins. **183** 225 (1925)[18].

Habitat : Krain, Balkan Peninsula, in Asia Minor, and the east coast of the Black Sea ; also near Trieste[16].

Dale captured a single specimen of this ant at Bournemouth, but F. Smith[2] and Saunders[5] give Wales as the habitat, as the former read " Barmouth " for Bournemouth[6].

It is curious that Saunders appeared to consider this insect to be a British species ; in 1884 he says it should be looked for in the New Forest and Bournemouth districts[8], and in his book he includes it in the British list, and not as introduced[11]. Bingham records it from the tropical fern house at Kew, and says it is

introduced in England[12]. There is no reason to suppose it was ever a native of this country.

Blöte records that this species, which used to be taken in the Botanic Gardens at Leiden, was no longer to be found there[17].

Paratrechina (Nylanderia) flavipes F. Smith.

Tapinoma flavipes F. Smith Trans. Ent. Soc. Lond. **1874** 404[1]. *Prenolepis flavipes* Dalla Torre Cat. Hym. 7 178 (1893)[2]; Donisthorpe Bull. R. Bot. Gard. Kew 3 122 (1908)[3]: Trans. Leicester Lit.-Phil. Soc. **12** 229 (1908)[4]. *Prenolepis* (*Nylanderia*) *flavipes* Emery Deutsch. Ent. Zeitschr. **1910** 132[5]. *Paratrechina* (*Nylanderia*) *flavipes* Emery Gen. Ins. **183** 220 (1925)[6].

Habitat : Japan.

A colony consisting of males, winged and deälated females, workers, pupae, and larvae was found amongst lily bulbs from Tokio in Kew Gardens[3].

Paratrechina (Nylanderia) steinheili For. var. minuta For.

Prenolepis steinheili v. *minuta* Forel Trans. Ent. Soc. Lond. **1893** 343[1]; Donisthorpe Bull. R. Bot. Gard. Kew 3 251 (1909)[2]. *Paratrechina* (*Nylanderia*) *Steinheili* v. *minuta* Emery Gen. Ins. **183** 223 (1925)[3].

Habitat : Antilles.

Workers were taken amongst palms from British Guiana in 1909, Kew Gardens[2].

Paratrechina (Nylanderia) vividula Nyl.

Formica vividula Nylander Acta. Soc. Sc. Fenn. 2 900 (1846)[1]. *Prenolepis vividula* Er. André Spec. Hym. Europe 2 204 (1881)[2]; Dalla Torre Cat. Hym. 7 180 (1893)[3]; Bignell Ent. Mo. Mag. **31** 132 (1895)[4]; Malloch Faun. Flor. Geol. Clyde Area 219 (1901)[5]; Butterfield Ent. Mo. Mag. **44** 63 (1908)[6]; Donisthorpe Bull. R. Bot. Gard. Kew 3 122 (1908)[7]: Trans. Leicester Lit.-Phil. Soc. **12** 229 (1908)[8]; *Prenolepis* (*Nylanderia*) *vividula* Emery Deutsch. Ent. Zeitschr. **1910** 131[9]. *Prenolepis vividula* Forel Int. Ent. Cong. Bruxelles 1910 2 83 (1911)[10]; Donisthorpe Ent. Rec. **28** 4 (1916)[11]. *Paratrechina* (*Nylanderia*) *vividula* Emery Gen. Ins. **183** 233 (1925)[12].

Habitat : Cosmopolitan species.

On April 21st, 1895, Bignell captured two specimens of this ant in his house at Plymouth, which had undoubtedly escaped from a young palm, brought from London the day before[4]. Malloch records it from hot-houses at Queen's Park, and in the Botanic Gardens, Glasgow[5]; and Butterfield as abundant in greenhouses at Lister Park, Bradford, in 1907[6]. It is represented in the Dale Collection by specimens taken at Llanelly (*Richardson*); Haliday found it in hot-houses in Ireland[7]; and Wooley sent me specimens to name from a hot-house at Leicester Frith.

I captured specimens at Kew in the palm house on March 23rd, 1896, and in 1908 it occurred in the "Hospital" (house No. 18),

where a nest, which was found under a flower-pot on October 28th, 1910, contained three males and one winged female. In March, 1914, Beck sent me specimens from Moyallon, near Portadown, in Ireland, where he had found them in Mr. Wakefield Richardson's hot-house, attending scales (*Lecanium hesperidum* L.) on banana leaves. Beresford has sent me specimens from Clonsilla, Co. Dublin, where, he tells me, a colony is established in a private house. Evans sent me specimens to name which he had taken in the Botanic Gardens at Edinburgh in August, 1898[11].

Paratrechina (Nylanderia) vividula Nyl. subsp. **antillana** For.

Prenolepis guatemalensis race *antillana* Forel Trans. Ent. Soc. Lond. **1893** 340[1]. *Prenolepis vividula* subsp. *antillana* Donisthorpe Bull. R. Bot. Gard. Kew **12** 369 (1911)[2]: Ent. Rec. **23** 15 (1911)[3]. *Paratrechina* (*Nylanderia*) *vividula* v. *antillana* Emery Gen. Ins. **183** 223 (1925)[4].

Habitat : Antilles.

Workers occurred for some years in the palm house in Kew Gardens[2] [3].

Paratrechina (Nylanderia) braueri Mayr. subsp. **donisthorpei** For.

Prenolepis caeciliae* Donisthorpe [*teste Forel*] Bull. R. Bot. Gard. Kew **3** 122 (1908)[1]. *Prenolepis* (*Nylanderia*) *braueri* subsp. *donisthorpei* Forel Bull. Soc. Vaud. Sc. Nat. **44** 64 (1908)[2]; Donisthorpe Trans. Leicester Lit.-Phil. Soc. **12** 229 (1908)[3]: Bull. R. Bot. Gard. Kew **6** 250 Pf. [1]·6 (1909)[4]: **12** 368 (1911[5]: Ent. Rec. **23** 15 (1911)[6]. *Paratrechina* (*Nylanderia*) *braueri* subsp. *donisthorpei* Emery Gen. Ins. **183** 221 (1925)[7].

Habitat : (?)

I captured specimens of this ant in Kew Gardens as long ago as 1896 ; it has occurred in the fern, palm, and lily houses, but the former house is evidently its headquarters, and there I found a male, on December 5th, 1910[6]. I sent Professor Forel a sketch of the genitalia of this specimen, and he tells me *P. donisthorpei* is probably a good species.

✓**Paratrechina (Paratrechina) longicornis** Latr.

Formica longicornis Latreille Hist. Nat. Fourm. 113 (1802)[1]. *Tapinoma gracilescens* Fowler Ent. Mo. Mag. **21** 276 (1885)[2]. *Prenolepis longicornis* Er. André Spec. Hym. Europe **2** 203 (1881)[3]; Dalla Torre Cat. Hym. **7** 179 (1893)[4]. *Tapinoma gracilescens* Farren-White Ants' Ways 65 237 (1895)[5]. *Prenolepis longicornis* Saunders Hym.-Acul. 26 (1896)[6]; Bingham Bull. R. Bot. Gard. Kew (AS) **5** 28 (1906)[7]; Frisby Ent. Mo. Mag. **43** 159 (1907)[8]; Assmuth Zeitschr. Wissens Insektenbiol. **3** 301–309 328–334 357–368 (1907)[9]; Donisthorpe Bull. R. Bot. Gard. Kew **3** 122 (1908)[10]: Trans. Leicester Lit.-Phil. Soc. **12** 228 (1908)[11]: Bull. R. Bot. Gard. Kew **6** 251 (1909)[12]. *Prenolepis* (*Nylanderia*) *longicornis* Emery Deutsch. Ent. Zeitschr. **1910** 129[13]. *Prenolepis longicornis* Forel Int. Ent. Cong. Bruxelles 1910 **2** 83 (1911)[14];

Crawley and Donisthorpe Int. Ent. Cong. Oxford 1911 **2** 23 (1912)[15]; Donisthorpe Ent. Rec. **28** 4 (1916)[16]: **32** 22 (1921)[17]. *Paratrechina* (*Paratrechina*) *longicornis* Emery Gen. Ins. **183** 217 (1925)[18].

Habitat : Cosmopolitan species.

Farren-White says this species was established in a rectory in the heart of the City of London and occurred in large numbers in 1876 and 1878; he also records it from the Crystal Palace, the lily house at Kew, St. Leonards-on-Sea, Hastings, Exeter, and in a hot-house at Cheltenham[5]. Fowler observed this ant in some numbers in a cottage in the centre of Lincoln, and the old woman who inhabited it said they had been present for a great number of years past, and she had never been able to get rid of the plague[2]. Bingham records it in the propagating pits at Kew, and from Cambridge, etc.[7]; and Frisby found it to be common about several shops at Linkfield Corner, Redhill, in 1906[8]. It is represented in the Dale Collection by specimens from Little Stanmore; in the Rothney Collection from hot-houses at Tottenham; and Scott sent it to me to name from Warnham Court near Horsham. It is usually abundant at Kew, where I have found it in the propagating pits and other houses; on one occasion I obtained a number of winged females[11], and a colony situated in a flower-pot consisted of thirteen deälated females, a number of workers, larvae, etc.[15].

Evans took it in Yester Gardens, Haddington, in August, 1904[16]; in January, 1906, Fryer sent it to me to name from hot-houses at Southgate; and on October 12th, 1920, I found it to be abundant in one of the hot-houses at the Botanic Gardens, Regent's Park[17]. The workers were running about on all the plants and pots, both in and around a large pond in the hot-house.

Acanthomyops (Donisthorpea) niger L. subsp. **lasioides** Emery.

Prenolepis lasioides Emery Ann. Acad. Aspiranti Nat. (SE) **2** 6 (1869)[1]. *Lasius niger alieno-brunneus* Forel Denkschr. Schweiz Ges. Naturw. **26** 47 (1874)[2]. *Lasius alienus* var. *lasioides* Dalla Torre Cat. Hym. **7** 182 (1893)[3]. *Lasius niger* subsp. *lasioides* Donisthorpe Bull. R. Bot. Gard. Kew **12** 369 (1911)[4]. *Lasius* (*Lasius*) *niger* subsp. *lasioides* Emery Gen. Ins. **183** 230 (1925)[5].

Habitat : Italy.

A deälated female taken in orchid house, Kew Gardens, October, 1911[4].

Camponotus (Camponotus) herculeanus L.

Formica herculeana Linnaeus Syst. Nat. Ed. 10 **1** 579 (1758)[1]; Berkenhout Outline NH. Gr. Brit. **1** 159 (1769)[2]; Headwick Don. Agri. Forfarshire Append. 53 (1813)[3]. *Formica herculanea*† Newman Entom. **3** 244 (1867)[4]: Proc. Ent. Soc. Lond. (S. 3) **5** LXXVI (1867)[5]. *Formica herculeana* Westwood Proc. Ent. Soc. Lond. **1871** XXVI[6]; Dunning Pro. Ent. Soc. Lond. **1871** XXXVIII[7]; *Camponotus herculeanus* r. *herculeanus* Forel Denkschr. Schweiz Ges. Naturw. **26** 39 (1874)[8]. *Formica herculanea*† Bridgman Trans. Norf.

Norwich Nat. Soc. **2** 276 620 (1877)[9]. *Camponotus herculeanus* Er. André Spec. Hym. Europe **2** 142 (1881)[10]; Dalla Torre Cat. Hym. **7** 233 (1893)[11]. *Camponotus herculanea*† Vic. Hist. Norfolk **1** 99 (1901)[12]. *Camponotus herculaneus*† Stainforth Nat. **28** 456 (1903)[13]. *Camponotus herculeanus herculeanus* Emery Deutsch. Ent. Zeitschr. **1908** 184[14]. *Camponotus (Camponotus) herculeanus* Forel Rev. Suisse Zool. **22** 266 (1914)[15]. *Camponotus (Camponotus) herculeanus* subsp. *herculeana*† Emery Bull. Soc. Ent. Italiana **47** 225 (1916)[16]. *Camponotus herculeanus* Menozzi Bull. Soc. Ent. Italiana **54** 142 (1922)[17]. *Camponotus (Camponotus) herculeanus* Emery Gen. Ins. **183** 72 (1925)[18].

Habitat : North and Central Europe.

Berkenhout gives this species as British, but without any locality[2], and Headwick lists it in the plants and animals of Forfarshire[3]; both records are extremely doubtful.

Newman said he had been informed that this ant had been taken from pine stumps near Rannoch[4], but F. Smith thought there was some mistake[5]. Westwood recorded on November 6th, 1871, that a Great Woodpecker (*Picus martius*), which was supposed to have been recently shot in Wytham Wood, Oxon, was found to have its crop crammed with perfect specimens of this ant[6]; but Dunning pointed out that several of these birds, from Norway, were for sale at this time in Leadenhall Market[7]. Bridgman records females and workers running on some birch bark from New Brunswick (these would be one of the American forms of *herculeanus*) in a saw-yard at Norwich in April, 1876[9], Stainforth a live worker taken in the Western Dock Reserve at Hull in September, 1902[13], and Butterfield took a female and workers at Keighley, Yorkshire, which had been imported in wood.

In February, 1926, G. D. Morison sent me males, females, soldiers, and workers to name, which had been found in large numbers between masses of paper pulp in paper mills on the banks of the Don at Aberdeen

Camponotus (Camponotus) herculeanus L. subsp. pennsylvanicus Retz.

[" Fourmi de Pensylvanie " Degeer Mém. Hist. Ins. **3** 603 (1773)[1].] *Formica pennsylvanica* Retzius Gen. Spec. Ins. Degeer 75 (1783)[2]. *Camponotus pennsylvanicus* Er. André Spec. Hym. Europe **2** 141 (1881)[3]. *Formica pennsylvatica*† Sommerville Proc. NH. Soc. Glasgow (n.s.) **1** VII (1883)[4]. *Camponotus pennsylvanicus* Dalla Torre Cat. Hym. **7** 246 (1893)[5]. *Campanotus herculeanus pennsylvanicus* Wheeler Ann. New York Acad. Sc. **20** 335 (1910)[6]. *Camponotus (Camponotus) herculeanus* subsp. *pennsylvanicus* Forel Rev. Suisse Zool. **22** 266 (1914)[7]; Wheeler Proc. Indiana Acad. Sci. **1918** 465[8]; Donisthorpe Ent. Rec. **35** 6 (1923)[9]: **37** 4 (1925)[10]; Emery Gen. Ins. **183** 73 (1925)[11].

Habitat : North America.

Wheeler writes of this species—" This is the common ' carpenter ant ', a large, entirely black species which usually nests in old logs and stumps in shady woods. It may migrate into old farm-houses and suburban residences and become a pest by riddling the wood-

work with its inosculating galleries and by visiting pantries and kitchens in search of sweets "[8].

Sommerville records living specimens nesting in a log of yellow pine on August 14th, 1883, received in Glasgow from Michigan, U.S.A.[4]; and winged females were sent to the British Museum (about 1918) from Alfreton, Derbyshire, which had been imported from America in ash poles[9]. Years ago Walker used to meet with it in the dockyard at Chatham; and in 1910 F. Taylor took females and workers in a timber yard at Oldham. In 1922 Saunt sent me to name a number of ants comprising males, winged females, soldiers, and workers, which proved to belong to this subspecies. He told me that about July 7th he noticed a large deälated female ant on the floor of a saw-mill at Coventry, which he realized was not a British species. On hunting about he found a plank of American oak which had been bored by Coleopterous larvae, and on cutting off a piece, a hole was exposed which was tightly packed with dead ants. After shaking out, and removing with tweezers a large number of these, the entrances to a central chamber were exposed, and inside he discovered five live winged females[9]. Again, on July 25th, 1924, Saunt sent me a number of live males, winged females, and workers of *pennsylvanicus* from a timber yard at Coventry, together with some large pieces of wood in which the ants had been found. I fixed the ants up in a "Janet" nest, feeding them on flies, honey, etc. On October 7th Saunt again sent me a large colony of the same ant—this consisted of very many soldiers and workers, two deälated females, and a few larvae. Having found that the old colony readily accepted workers from the new lot, I placed the "Janet" nest in a large zinc tray with a water-trough all round it, and dumped all the new ants on to the tray. During the night the latter joined forces with the older colony, all the ants entering the nest through a hole which I had bored in the side. Subsequently they made other holes, which they excavated right through the plaster sides, with their mandibles. The ants were fed with raw meat, cake, fruit, honey, etc., and they usually came out at night to feed.

From the above account two points stand out—(1) that both colonies must have sprung from a common stock, and (2) that the larvae had been bred in this country.

It seems curious that this ant which has frequently been found in this country in introduced timber, in timber yards (in 1925 and 1926 Saunt again found very many examples at Coventry), and dockyards, etc., has not established itself, at some time or other, with us. I can only think that it is our wet winters which have prevented this. This ant occurs in Canada and extends to Texas and Louisiana. The female after the marriage-flight gets rid of her wings and selects a hole, or the empty cocoon of a Longicorn beetle, etc., under the loose bark of a tree, or stump, in which to found her colony. As we have seen males and winged females

occurred in plenty, and there would seem nothing to prevent a female, after her marriage-flight, from flying to the nearest wood, or forest, and founding a colony[10].

Camponotus (Myrmentoma) caryae A. Fitch var. **fallax** Nyl.

Formica fallax Nylander Ann. Sci. Nat. Zool. (4) **5** 57 (1856)[1]. *Camponotus marginatus* Dalla Torre [in part] Cat. Hym. **7** 242 (1893)[2]. *Camponotus* (*Camponotus*) *falax* Emery Bull. Soc. Ent. Italiana **47** 226 (1916)[3]. *Camponotus* (*Camponotus*) *fallax fallax* Donisthorpe Ent. Rec. **28** 4 (1916)[4]. *Camponotus caryae* v. *fallax* Wheeler Psyche **34** 27 (1917)[5]. *Camponotus* (*Myrmentoma*) *caryae* v. *fallax* Emery Gen. Ins. **183** 118 (1925)[6].

Habitat : Central and Southern Europe.

Mitford sent me a deälated female of this ant which was taken in London, in the City, on October 15th, 1915, crawling on a cargo of deals and boards from the shore of the White Sea[4].

Camponotus (Myrmentoma) caryae A. Fitch subsp. **rasilis** Wheeler var. **pavidus** Wheeler.

Camponotus fallax rasilis var. *pavidus* Wheeler Journ. New York Ent. Soc. **18** 228 (1910)[1] : Ann. New York Acad. Sc. **20** 342 (1910)[2]. *Camponotus* (*Myrmentoma*) *caryae* subsp. *rasilis* v. *pavidus* Emery Gen. Ins. **183** 117 (1925)[3] ; Donisthorpe Ent. Rec. **38** 19 (1926)[4].

Habitat : Texas ; Louisiana ; Florida[2].

Males, winged females, and workers occurred in some numbers in a cooperage belonging to Messrs. Bulmer, cider merchants, Hereford, in April, 1911. The ants were living in the oak, used for binding the casks, which came from Texas. Saunt captured workers and soldiers on American ash in a timber yard at Coventry on May 9th, 1925[4].

Camponotus (Tanaemyrmex) sylvaticus Oliv.

Formica sylvatica Olivier Encycl. Méth. Ins. **6** 491 (1791)[1]. *Camponotus sylvaticus* r. *sylvaticus* Forel Denkschr. Schweiz Ges. Naturw. **26** 39 (1874)[2]. *Camponotus sylvaticus* Er. André Spec. Hym. Europe **2** 144 (1881)[3] *Camponotus silvaticus*† Dalla Torre Cat. Hym. **7** 252 (1893)[4]. *Camponotus sylvaticus* Vic. Hist. Durham **1** 95 (1905)[5]. *Camponotus maculatus silvaticus*† Emery Deutsch. Ent. Zeitschr. **1908** 199[6]. *Camponotus* (*Tanaemyrmex*) *sylvaticus* Emery Gen. Ins. **183** 100 (1925)[7].

Habitat : South of France[6].

This species is recorded as being taken alive in bananas at Bishop Auckland[5].

Camponotus (Myrmothrix) abdominalis F.

Formica abdominalis Fabricius Sys. Piez. 409 (1804)[1]. *Camponotus abdominalis* Dalla Torre Cat. Hym. **7** 219 (1893)[2]. *Camponotus* (*Myrmothrix*) *abdominalis* Forel Rev. Suisse Zool. **22** 268 (1914)[3]; Donisthorpe Ent. Rec. **36** 53 (1924)[4] ; Emery Gen. Ins. **183** 107 (1925)[5] ; Donisthorpe Ent. Rec. **38** 19 (1926)[6].

Habitat : Central and South America.

Frisby found winged females of this species in a bunch of bananas at Gravesend ; and Britten gave me workers also taken amongst bananas at Penrith, Cumberland, in 1906 (*J. V. Smith*).

Miss Tassart gave me a soldier and worker of a small form of this species, which she had found on some apples in her house at Clapham Common in January, 1923[4] ; and Massee sent me a number of soldiers and workers found in a bunch of bananas at Malling in October, 1925[6]. Hallett has also found it in bananas at Cardiff. It is often abundant in a wholesale banana dealer's shop in Aberdeen.

Camponotus (Myrmothrix) abdominalis F. var. atriceps F. Smith.

Formica atriceps F. Smith Cat. Hym. Brit. Mus. 6 44 (1858)[1]. *Camponotus abdominalis* Dalla Torre Cat. Hym. 7 219 (1893)[2] [in part]. *Camponotus abdominalis* var. *atriceps* Donisthorpe Proc. Ent. Soc. Lond. **1912** CII[3] ; Emery Gen. Ins. **183** 107 (1925)[4].

Habitat : South America.

I captured a large worker of this variety in my flat on the evening of September 6th, 1912, having been at Weybridge during the day. It is probable that it came from the hotel at Weybridge, as I was told of the capture of other specimens there on my next visit[3].

Butterfield has taken it on bananas at Glenridding near Bradford in Yorkshire.

In October, 1926, I was given a live winged female, soldiers, and workers ; part of a small colony taken with "nest materials" in a bunch of bananas by a fruiterer in London.

Camponotus (Myrmothrix) abdominalis F. subsp. stercorarius For.

Camponotus atriceps race *stercorarius* Forel Bull. Soc. Vaud. Sc. Nat. (2) **20** 340 (1884)[1]. *Camponotus stercorarius* Dalla Torre Cat. Hym. 7 253 (1893)[2]. *Camponotus abdominalis* subsp. *stercorarius* Donisthorpe Bull. R. Bot. Gard. Kew **12** 369 (1911)[3]. *Camponotus* (*Myrmothrix*) *abdominalis* subsp. *stercorarius* Emery Gen. Ins. **183** 108 (1925)[4].

Habitat : Central America.

A large worker was captured on a clump of imported *Laelia gouldiana* in the orchid house at Kew[3] ; Bedwell found another in an orchid house at Potters Bar ; and Hudd sent me a deälated female, large and small workers taken on bananas at Cardiff in 1910.

Camponotus (Myrmophaenus) novogranadensis Mayr.

Camponotus novogranadensis Mayr Sitz. Akad. Wiss. Wien **61** (1) 380 (1870)[1] ; Dalla Torre Cat. Hym. 7 245 (1893)[2]. *Camponotus* (*Myrmamblys*) *novogranadensis* Forel Rev. Suisse Zool. 22 272 (1914)[3]. *Camponotus* (*Myrmophaenus*) *novogranadensis* Emery Gen. Ins. **183** 156 (1925)[4].

Habitat : Central America ; Columbia, Brazil.

Large and small workers were captured in orchids from Brazil at Kew Gardens in December, 1912.

Camponotus (Myrmotrema) perrisi Forel subsp. nigeriensis Santschi.

Camponotus (*Myrmotrema*) *bayeri* st. *nigeriensis* Santschi Boll. Lab. Zool. Agri. Portici **8** 383 (1914)[1]. *Camponotus* (*Myrmotrema*) *perrisi* st. *nigeriensis* Santschi Ann. Soc. Ent. France **84** 277 (1915)[2]; Crawley Ent. Rec. **36** 91 (1924)[3]; Donisthorpe Ent. Rec. **36** 92 (1924)[4]; Emery Gen. Ins. **183** 131 (1925)[5].

Habitat : Nigeria and Belgian Congo.

Crawley recorded that workers and alate females of this subspecies were found in cases containing two termites' nests, sent to the British Museum from Nigeria for exhibition at Wembley[3]. On May 9th, 1924, when walking through the section devoted to Nigeria at Wembley, I observed a number of live ants (winged females, soldiers, and workers of this subspecies) crawling about in one of the show cases. In this case were exhibited a number of butterflies on grass stems ; an earthen termites' nest ; and a representation of a raid by "driver ants." The secretary of the section told me that the ants had commenced to emerge from the termites' nest four days after it had been fixed up in the case, and he had the glass sides unscrewed to enable me to take as many of the ants as I wished. The ants must have been in considerable numbers in the termites' nest, as Laing found them in evidence in some numbers subsequent to my visit[4].

Camponotus (Colobopsis) truncatus Spin.

Formica truncata Spinola Ins. Ligur. Spec. Nov. **2** 244 (1808)[1]. *Colobopsis truncata* Forel Denkschr. Schweiz Ges. Naturw. **26** 44 215 387 (1874)[2]; Er. André Spec. Hym. Europe **2** 160 (1881)[3]. *Camponotus truncatus* Dalla Torre Cat. Hym. **7** 255 (1893)[4]. *Camponotus* (*Colobopsis*) *truncatus* Donisthorpe Bull. R. Bot. Gard. Kew **6** 251 Pf. [1]·1–2 (1909)[5]; Forel Rev. Suisse Zool. **22** 272 (1914)[6]; Emery Gen. Ins. **183** 350 (1925)[7].

Habitat : South and Central Europe ; North Africa.

In April, 1909, I found a number of soldiers and workers of this species in virgin cork in company with *Cremastogaster scutellaris*, in the fern house in Kew Gardens ; a beetle *Formicomus pedestris* Ross., superficially very like the *Colobopsis* worker, occurred with them[5]. Pool sent this ant to me to name, taken in cork in the insect house in the Zoological Gardens, Regent's Park, July, 1914.

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INDEX (SYSTEMATIC).

ANTS.

(Genera are spelt with a capital letter, species otherwise, synonyms are in italics, asterisks (*) signify errors, sections (§) homonyms, and daggers (†) errors in spelling, for which Author disclaims all responsibility.)

abdominalis, Camponotus, 403
abeillei, Ponera, 77
Acanthomyops, 206
acervorum, Leptothorax, 164
Adformica, 316
Aecophthora, 103
affinis, Acanthomyops, 273
affinis, Leptothorax, 173, 178
**affino-tuberum, Leptothoras*, 185
affino-umbratus, var., Acanthomyops, 273
albipennis, Stenamma, 172
**albipennis, Stenamma*, 181
albipes, Technomyrmex, 395
aliena, Donisthorpea, 243
alieno-niger, var., Acanthomyops, 241
alieno-nigra, var., Donisthorpea, 241
alienus, Acanthomyops, 242
alluaudi, Plagiolepis, 396
alpina, var., Formica, 307, 335
americana, subsp., Myrmecina, 84
americana, var., Acanthomyops, 244
androgyna, Ponera, 73
Anergates, 95
antiguensis, Formica, 103
antillana, subsp., Paratrechina, 399
aphidicola, var., Brachymyrmex, 397
aphidicolus, var., Acanthomyops, 277
apicalis, Formica, 286
arduennae, var., Myrmica, 146
argentata, Formica, 257
Asemorhoptrum, 154
atavia, Ponera, 70
**atratula, Myrmica*, 190
atratulus, Anergates, 96
atriceps, var., Camponotus, 404
auro-punctata, Wasmannia, 393

barbata, Formica, 350
bicornis, Acanthomyops, 273
bidens, Myrmica, 80
binodis, Formica, 190
boerorum, subsp., Ponera, 386
brevicornis, Acanthomyops, 239
brevispinosa, var., Myrmecina, 84
britteni, Cardiocondyla, 391
**brunnea, Formica*, 276
brunneus, Acanthomyops, 247, 269, 278
brunneipes, var., Technomyrmex, 396

caerulescens, Formica, 200
caespitum, Myrmica, 135
caespitum, Tetramorium, 98, 190
Camponotinae, 66
capsincola, Formica, 350
cellarum, var., Pheidole, 390
chamberlini, Symmyrmica, 91
Chthonolasius, 209
cinerea, Formica, 335
cingulata, Myrmica, 173
clavigera, Acanthomyops, 206, **209**
clypeatus, Leptothorax, 161
coarctata, Ponera, 68
collina, Tapinoma, 200
Colobopsis, 405
congerens, Formica, 309
consocians, Formica, 299
contracta, Formica, 67, 68
corticalis, Leptothorax, 173, 178
crassinoda, Formica, 67
cunicularia, Formica, 335, 359, **361**, 366, 368

dakotensis, Formica, 299
debilis, Myrmica, 153
Dendrolasius, 209
denticornis, Myrmica, 145
destructor, Monomorium, 385, 387
diluta, Myrmica, 125
Diplorhoptrum, 103, 104
diversus, Pheidologeton, 387
Dolichoderinae, 199, 394
domestica, Myrmica, 103
domesticum, †Ciphlorophum, 104

dominula, Formica, 323
Donisthorpea, 208, 210
donisthorpei, subsp., Paratrechina, 399
dorsata, Formica, 286
dufourii, Micromyrma, 200
dusmeti, var., Formica, 308

eduardi, Ponera, 75, 76, 77
emarginatus, Acanthomyops, 268, 269
**emarginatus, Lasius*, 286
emeryi, Cardiocondyla, 385
erraticum, Tapinoma, 200
exacta, Ponera, var., 76
exigua, Plagiolepis, 396
exsecta, Formica, 315
exsectoides, Formica, 299, 318

fallax, var., Camponotus, 403
filchneri, var., *Formica*, 375
flavus, Anchomyops, 254
flavidula, Myrmica, 110
flavidula, Plagiolepis, 396
flavipes, Formica, 349
flavipes, Paratrechina, 398
**flavus, Lasius*, 262
flori, Formica, 351
floricola, Monomorium, 385
Formica, 281
Formicina, 209
Formicinae, 205, 396
Formicoxenus, 88
**fugax, Diplorhoptrum*, 103
fugax, Solenopsis, 110
**fugax, Solenopsis*, 125
fukaii, var., Formica, 318
fuliginosus, Acanthomyops, 211
fusca, Formica, 349
**fusca, Formica*, 190, 229, 361, 362
fusco-rufibarbis, var., *Formica*, 360, 361, 366
fuscula, Myrmica, 97, 190

gagates, Formica, 335, 375, 378
**gagates, Formica*, 374
geminata, Solenopsis, 109, 385
gertrudae, Pheidole, 389
glabra, Formica, 374
glabrella, Formica, 200
glacialis, Formica, 351
**glebaria, Formica*, 350, 369
glebaria, var., Formica, 360, 361
gracilescens, Tapinoma, 399
gracilis, Pseudomyrma, 387
graminicola, Formica, 79, 80
graminicola, Formica, 164
**graminicola, Formica*, 153
graminicola, Myrmecina, 80
guineense, Tetramorium, 74, 385, 391

haematodes, Odontomachus, 385
hammi, var., Tetramorium, 199
**herculanea, Formica*, 286
herculeanus, Camponotus, 400
humilis, Iridomyrmex, 385, 394

impura, Myrmica, 190
incisa, Strumigenys, 393
incompleta, Myrmica, 118
incerta, Formica, 299
indica, var., Diacamma, 386
interruptus, Leptothorax, 173, 185

japonica, Ponera, 77

kollari, Tetramorium, 391

lacteipennis, Myrmica, 164
laevigata, Myrmica, 389
laevinodis, Myrmica, 118
laeviuscula, Myrmica, 89
**laeviuscula, Myrmica*, 153
lasioides, subsp., Donisthorpea, 400
§*Lasius*, 206, 210
latreillei, Myrmecina, 80
Leptothorax, 161
ligniperdus, Camponotus, 320
lineolata, Cremastogaster, 388
lippula, Myrmica, 153, 391
lobicornis, Myrmica, 145
longicornis, Paratrechina, 385, 399
longipes, Plagiolepis, 385
longiscapus, Myrmica, 118
lucidula, Myrmica, 89
lugubris, Formica, 286

maculipes, Myrmica, 97, 190
magitae, Tetramorium, 392
major, var., *Formica*, 286
mandibularis, Solenopsis, 109
Manica, 181
manni, Formica, 324
mayri, Anochetus, 386
megacephala, Pheidole, 385, 389
melanocephalum, Tapinoma, 385, 395
mellea, Formica, 256
microcephalum, Liometopum, 267
microgyna, Formica, 283, 299
minkii, Myrmica, 153
minuta, Atta, 103
minuta, var., Paratrechina, 398
minutum, Monomorium, 102, 387
minutum, Tapinoma, 395
**mixta, Formica*, 262

mixto-umbratus, var., Acanthomyops, 273
mixtus, Acanthomyops, 276
modesta, Myrmica, 190
**molesta, Myrmica*, 104
molesta, Solenopsis, 104
Monomorium, 102
munda, Formica, 324
mutica, Myrmica, 91
Mychothorax, 162, 165
Myrmecina, 79
Myrmentoma, 403
Myrmica, 115
Myrmicinae, 77, 387
myrmicoxena, Myrmica, 150
Myrmophaenus, 404
Myrmothrix, 403, 404
Myrmotrema, 405

nearcticus, Acanthomyops, 256
neoniger, Acanthomyops, 246
niger, Acanthomyops, 229
**niger, Lasius*, 254, 257
nigeriensis, subsp., Camponotus, 405
nigerrima, Formica, 229
**nigra, Formica*, 349
nigra, Donisthorpea, 229
nigra major, Formica, 349
nigro-brunneus, var., Acanthomyops, 249
nipponensis, var., Acanthomyops, 213
nitens, Prenolepis, 397
nitidulus, Formicoxenus, 89
nitidula, Myrmica, 88, 89
**nitidula, Myrmica*, 154
**nitidulus, Formicoxenus*, 154
†*nodicornis, Myrmica*, 146
novogranadensis, Camponotus, 404
nylanderi, Leptothorax, 173
Nylanderia, 398, 399

obscura, var., Holcoponera, 385
obsoleta, Formica, 286, 368
**ochracea, Ponera*, 73
opaciceps, Ponera, 386

pallescens, Formica, 229
**pallidula, Pheidole*, 339
pallitarsis, Formica, 244
patagonicus, Brachymyrmex, 397
pavidus, var., Camponotus, 403
pennsylvanicus, subsp., Camponotus, 401
perelegans, Myrmica, 132
pharaonis, Monomorium, 103, 385, 387
picea, Formica, 374
picea, var., Camponotus, 375
picea, var., Formicoxenus, 91
**piliger*, var., *Formica*, 369
piniphila, Formica, 286, 304
polita, Tapinoma, 397
polyctena, Formica, 286, 304
Polyergus, 328
Ponera, 67
Ponerinae, 67, 385
pratensis, Formica, 309
**pratensis, Formica*, 368
pressilabris, Formica, 299, 316
punctatissima, Ponera, 73
punctulata, var., Pheidole, 389
pusilla, Oecophthora, 389
pygmaea, Micromyrma, 200

ragusai, Ponera, 77
Raptiformica, 283, 324
ravouxi, Formicoxenus, 92
regulare, Ectatomma, 385
reticulata, Myrmica, 391
rhombinoda, Pheidole, 390
rogeri, Strumigenys, 393
rubens, var., Formica, 322
**rubescens, Serviformica*, 369
rubescens, var., Formica, 360, 366
rubida, Myrmica, 91
rubicunda, Formica, 329, 336, 342, 343
rubra, Formica, 115, 116, 118
rufa, Formica, 286
**rufa, Formica*, 309, 368
rufescens, Formica (=Polyergus), 334
rufibarbis, Formica, 359, 368
**rufibarbis, Formica*, 361, 366
ruficornis, Formica, 256
rufo-pratensis, var., Formica, 304
ruginodis, Myrmica, 125
ruginodo-laevinodis, var., Myrmica, 123

sabuleti, var., Myrmica, 143
sanguinea, Formica, 323
santschii, var., *Formica*, 307
scabrinodis, Myrmica, 135
schencki, Myrmica, 150
schiefferdeckeri, Acanthomyops, 231
schmidti, var., Tetramorium, 199
scutellaris, Cremastogaster, 388, 405
semilaeve, var., Tetramorium, 199
Serviformica, 283, 324
sexdens, var., Tetramorium, 392
simillimum, Tetramorium, 385, 392
simpliciuscula, Myrmica, 185
Solenopsis, 109
Stenamma, 152

stenoptera, Formica, 368
stercorarius, subsp., Camponotus, 404
striatidens, Triglyphothrix, 385, 393
strictula, Myrmica, 80
subintegra, Formica, 343
subpolita, Formica, 324
subsericea, Formica, 299, 356
sulcinodis, Myrmica, 132
sulcinodo-ruginodis, var., Myrmica, 131
sylvaticus, Camponotus, 403

Tanaemyrmex, 403
Tapinoma, 199
tarda, Ponera, 73, 77
terminalis, Cremastogaster, 388
Tetramorium, 189
texana, subsp., Myrmecina, 84
theresiae, Neoponera, 386
timida, Formica, 247
transkaukasica, Formica, 374
tristis, Formica, 349
truncatus, Camponotus, 405
truncicola, Formica, 299, 308
**truncicola, Formica,* 286
truncicolo-pratensis, var., *Formica,* 308
tubero-affinis, Leptothorax, 364
**tubero-affinis, Leptothorax,* 185
tuberosa, Formica, 181
tuberum, Leptothorax, 173, 181
**tuberum, Leptothorax,* 179
**tuberum, Myrmica,* 173

umbratus, Acanthomyops, 262
**unifasciata, Formica,* 103
**unifasciata, Leptothorax,* 181
unifasciatus, Leptothorax, 172, 173

vagans, Myrmica, 125
vividula, Paratrechina, 385, 398

wesmaeli, Myrmica, 132
westwoodi, Stenamma, 152
**westwoodi, Stenamma,* 90, 125
westwoodii, Myrmica, 89

MYRMECOPHILES.

(The term is used in its widest sense here.)

COLEOPTERA

acuminata, Homoeusa, 227, 241, 261, 281, 358
adnexus, Batrisodes, 254
analis, Atheta, 142, 228, 254, 303, 323
anceps, Notothecta, 303, 307, 323
angulata, Thiasophila, 227, 303, 307
atratus, Xantholinus, 228, 303
aurata, Cetonia, 303
bennetti, Ilyobates, 227
bicolor, Medon, 261
brevis, Quedius, 228, 303, 307, 348
brunnea, Atheta, 228
canaliculata, Drusilla, 72, 123, 131, 135, 142, 172, 198, 228, 241, 247, 253, 261, 303, 322, 348, 358, 365
carinatus, Neuraphes, 358
claviger, Euconnus, 154
cognata, Myrmedonia, 228
collaris, Myrmedonia, 123
confusa, Notothecta, 228, 303
conicicollis, Monotoma, 303, 307, 315
consanguinea, Atheta, 228, 272
corticalis, Dryophthorus, 249, 254
delaportei, Batrisodes, 253, 254
dentata, Dinarda, 348
distincta, Coccinella, 303
emarginatus, Atemeles, 123, 131, 135, 142, 145, 358
exarata, Atheta, 228
exilis, Scydmaenus, 254, 303
ferrugineus, Hetaerius, 261, 303, 348, 358
flavipes, Notothecta, 303, 307, 309, 323, 348
floricola, Cetonia, 303, 315
formiceticola, Oxypoda, 302, 315
formicetorum, Euthia, 254
formicetorum, Monotoma, 303
formicetorum, Leptacinus, 254, 303, 307, 315, 374
funesta, Myrmedonia, 227
gentilis, Microglossa, 227, 253
glaber, Xantholinus, 254
glabratus, Bythinus, 72
glabriventris, Ilyobates, 227
godarti, Scydmaenus, 254, 303
gracilis, Tachyusida, 253
gressneri, Ptenidium, 228
haemorrhoa, Oxypoda, 227, 302, 307, 315, 322, 348

hagensi, Dinarda, 322
haworthi, Myrmedonia, 227
humeralis, Myrmedonia, 227, 272, 289, 303
inquilina, Thiasophila, 227
kraatzi, Ptenidium, 254, 303
latebricola, Staphylinus, 131, 272, 303
laticollis, Myrmedonia, 228
latus, Symbiotes, 254
limbata, Myrmedonia, 142, 227, 241, 253, 261, 322, 348, 358
longicornis, Claviger, 241, 281
lugens, Myrmedonia, 228
marginata, Amphotis, 224, 228
märkeli, Dinarda, 303
märkeli, Trichonyx, 228, 261, 358
montandoni, Trichopteryx, 254, 272, 303, 315
myrmecophilum, Ptenidium, 228, 315
myrmecophilum, Ptilium, 303
myrmecophilus, Othius, 142, 228, 254, 303, 323, 348
nigra ? Heterothops, 228, 303
nigricollis, var., Atemeles, 125
nitidula, Atheta, 228, 254
onopordi, Larinus, 352
optabilis, Euryusa, 254
paradoxus, Atemeles, 123, 360, 365, 374
parallela, Atheta, 303, 307
pedestris, Formicomus, 405
piceus, Myrmetes, 303
plicata, Myrmoecia, 205
propinquus, Ilyobates, 253
pulla, Microglossa, 227, 253, 302
punctatus, Dendrophilus, 228, 254, 303, 323
pygmaea, Dinarda, 360, 365, 374
pygmaeus, Dendrophilus, 303, 307
quadripunctata, Clythra, 303, 307
recondita, Oxypoda, 253, 302, 348
ruficornis, Aleochara, 227, 302, 358
sabulosum, Opatrum, 241, 365
saginatus, Lamprinus, 72, 131, 145, 261, 312, 348, 358
sanguinea, Aleochara, 253
scitus, Quedius, 254
sinuata, Euryusa, 254
sodalis, Atheta, 254, 303
stercorarius, Staphylinus, 123, 131, 142, 198, 303
strumosa, Lomechusa, 339, 340, 348
subpilosus, Ptinus, 254
testaceus, Claviger, 241, 247, 261
turgidum, Ptenidium, 254
venustus, Batrisodes, 142, 228, 254, 303, 358
vittata, Oxypoda, 227

HYMENOPTERA PARASITICA

abdominalis, Ceraphron, 303
aequata, Diapria, 254
albitarse, Polynema, 303
alutaceus, Conostigmus, 254
amempsimus, Eulophus, 228
anthracinus, Bracon, 228
anthracinus, Pezomachus, 241
apterum, Chasmodon, 228, 358
aquisgranensis, Pezomachus, 131, 142
aterior, var., Lagynodes, 228
berolinense, Elasmosoma, 303
bicolor, Gonatopus, 134, 241
brachialis, Synacra, 254
brevifilis, Antaeon, 358
buccata, Pachylomma, 131, 142, 150, 205, 241, 247, 261, 303, 307, 349, 374
cantianum, Pseudisobrachium, 72
compar, Blacus, 365
concolor, Aspilota, 358
cynipseus, Litus, 241
distinctus, Gonatopus, 123, 365
distinguendus, Gonatopus, 241
donisthorpei, Loxotropa, 261
donisthorpei, Tetramopria, 198
donisthorpei, var., Exallonyx, 142
dubius, Conostigmus, 254
erythromera, Spalangia, 228
falconivibrans, Spilomma, 358
femoralis, var., Tetramopria, 198
formicaria, Kleditoma, 303
formicaria, Rhoptromeris, 359
formicaria, Trichopria, 359
formicaria, var., Belyta, 228
formicarius, Aphanogmus, 303
formicarius, Bethylus, 228
formicarum, Ceraphron, 303
formicarum, Conostigmus, 303
formicarum, Loxotropa, 228
fuliginosi, Ceraphron, 228
fuliginosi, Loxotropa, 228
fuliginosus, Tropidopria, 228, 303
fuscicola, Synopeas, 359
fuscipes, Proctotrypes, 228
gracilicollis, Anteon, 172
gravidator, Proctotrypes, 349
hospes, Plesiobaeus, 359
hyalinus, var., Amblyaspis, 228
innotatus, Conostigmus, 254
intermedius, Pezomachus, 349
lasiophila, Aclista, 228
lasiophilus, Amblyaspis, 228
leptothorax, Conostigmus, 254
lucidus, Conostigmus, 254
mamillans, Blacus, 241

marshalli, Acanthopsilus, 228
micropterus, Microcryptus, 303
muricatus, Liophron, 228
myrmecobia, Conostigmus, 303
myrmecobius, Hoplogryon, 228
myrmecobius, Teleas, 228
myrmecophila, Kleditoma, 228, 303
myrmecophilus, Ceraphron, 303
myrmecophilus, Exallonyx, 228
myrmecophilus, Gonatopus, 241
myrmecophilus, Leptorhaptus, 228
myrmecophilus, Paragryon, 261
myrmicarum, Ceraphron, 131
neesii, var., Pezomachus, 123
nervosa, Aspilota, 228
nigriceps, Belyta, 254
nigro-cinctus, Microcryptus, 123
oratorius, Gonatopus, 384
pallidus, Lagynodes, 228, 303, 359
pedestris, Planopria, 241
pilosus, Gonatopus, 198, 241, 247
psiloides, Kleditoma, 228
pugnatrix, Misocrina, 228
ruddi, Embolemus, 359
rufiventris, Acropiesta, 254
rufo-petiolatus, var., Amblyaspis, 228
scotica, Aclista, 254
scoticus, Ceraphron, 254
scoticus, Conostigmus, 254
seminulum, Baeus, 303
sociabilis, Gonatopus, 198
sociabilis, var., Exallonyx, 228
sociata, Ashmedopria, 303
spinifer, Ceraphron, 228
striatus, Gonatopus, 261, 358
striolata, Acropiesta, 254
subcyaneum, Pseudisobrachium, 85
subintegra, Kleditoma, 303
subregonensis, Loxotropa, 228
subterranea, Loxotropa, 241, 261
subterranea, var., Ceraphron, 323
tenuicornis, Aphanogmus, 254
testaceipes, Conostigmus, 228, 303
tritoma, Loxotropa, 198
viator, Acoelius, 303
vulpinus, Pezomachus, 303
wasmanni, Conostigmus, 303
wasmanni, Exallonyx, 228

LEPIDOPTERA

alcon, Lycaena, 198
arion, Lycaena, 142, 145
bellargus, Lycaena, 235
corydon, Lycaena, 258
eros, Polyommatus, 134
incongruella, Amphisbatis, 323
ochraceella, Myrmecozela, 303, 309

DIPTERA

aequalis, Apiochaeta, 228, 254
aterrima, Trineura, 228
blattoides, Aenigmatias, 383
brachyptera, Peyerimhoffia, 247
braueri, Ceratopogon, 359
brevicauda, Pseudacteon, 131
ciliata, Apiochaeta, 228, 254
conformis, Apiochaeta, 131
crassimana, Limosina, 254
curtiventris, Limosina, 228
donisthorpei, Phyllomyza, 228
dorni, Platyphora, 374
eggeri, Microdon, 241
femorata, Apiochaeta, 131
formicae, Phyllomyza, 303, 307
formicarum, Pseudacteon, 150, 205, 228, 241, 247, 261, 272, 349
fungicola, Limosina, 228, 303
highlandica, var., Platyphora, 359
infumata, Scatopse, 228, 303
lasiae, Phyllomyza, 228
longicostalis, Apiochaeta, 228
lubbocki, Platyphora, 359, 383, 384
lucorum, Atrichopogon, 254
ludens, Milichia, 228
Microdon, 382
mutabilis, Microdon, 131, 241, 359
myrmecophilus, Ceratopogon, 303, 323
nervosa, Drapetis, 359
pulicaria, Apiochaeta, 303
rata, Apiochaeta, 323
rufilabris, Limosina, 359
sp. ?, Limosina, 228
subterranea, Peyerimhoffia, 359
transversalis, Scatopse, 228, 303
truncorum, Medeterus, 303

HETEROPTERA

beckeri, Megacoelum, 303
calcaratus, Alydus, 241, 303, 349, 359, 365
cinnamopterus, Pilophorus, 303
coleoptrata, Myrmedobia, 123, 228, 241
coleopteratus, Ceratocombus, 323, 359
formicetorum, Piezostethus, 303
gracilis, Myrmecoris, 241, 303
lativentris, Nabis, 142, 241, 247, 261, 303, 349, 359, 365
obliqua, Tettigometra, 203
perplexus, Pilophorus, 228, 241, 254, 303, 349, 359
tricornis, Dictyonata, 261
triguttatus, Systellonotus, 241, 359

APHIDAE

albicornis, Geoica, 261
alienus, Aphis, 247
carnosa, Geoica, 241, 247, 261
cimiciformis, Paracletus, 198, 261
corni, Schizoneura, 123, 131, 142, 219, 228, 241, 261, 281, 303, 359
donisthorpei, Paracletus, 203
donisthorpei, Trama, 198
formicaria, Forda, 123, 142, 198, 241, 247, 261, 272, 359
formicarium, Macrosiphum, 261
formicina, Geoica, 241, 272
formicophilus, Lachnus, 303
furcata, Forda, 123
heraclei, Aphis, 131
hexagona, Forda, 261
hirsutum, Tycheoides, 261
humuli, Phorodon, 281
lactucaria, Brysocrypta, 131, 142
leontodoniella, Aphis, 261
longirostris, Stomaphis, 251, 254
marginata, Pentaphis, 198, 241, 359
myrmecophilum, Macrosiphum, 241
nudus, Lachnus, 359
pellucida, Geoica, 261
phillipsi, Macrosiphum, 261
plantaginis, Aphis, 131, 241, 261, 303
quercus, Stomaphis, 219, 228, 251, 254
radicis, Trama, 142, 241, 247, 261, 359
ranunculi, Aphis, 261
ranunculi, Brysocrypta, 131, 142, 359
setariae, Tycheoides, 131, 261, 272, 365
setulosa, Tycheoides, 123, 251
sonchi, Macrosiphum, 261
subterranea, Aphis, 247
trivialis, Pentaphis, 123, 198, 241, 261
troglodytes, Trama, 142, 241, 247, 261
ulmi, Tetraneura, 142, 198, 247, 261, 359
viridana, Forda, 142, 247, 261

COCCIDAE

aceris, Pseudococcus, 219
caraphracta, Orthezia, 303
donisthorpei, Ripersia, 72
europaea, Ripersia, 241, 359
floccosa, Newsteadia, 228, 303, 359, 384
formicarii, Ripersia, 241, 247, 261
formicarum, Lecanopsis, 241
hesperidum, Lecanium, 234, 346
persicae, Lecanium, 219
rubi, Lecanium, 219
sphagni, Pseudococcus, 383, 384
subterranea, Ripersia, 198, 241, 247, 261, 365
tomlini, Ripersia, 241, 261, 359
vejdovskyi, Ortheziola, 143, 241, 247, 261
vitis, Coccus, 234

COLLEMBOLA

albinos, Cyphodeirus, 72, 123, 124, 131, 135, 143, 145, 150, 152, 161, 172 198, 205, 228, 241, 247, 254, 261, 272, 281, 315, 323, 349, 359, 365, 368, 374, 383
caecus, Smynthurus, 131, 359
cavernarum, Lepidocyrtus, 228

MYRIAPODA

fuscus, Proterojulus, 254, 303
guttulatus, Blanjulus, 323
lagurus, Polyxenus, 241, 303, 359
pulchellus, Julus, 228, 303

ARANEINA

arietinus, Tetrilus, 228, 241, 254, 303
biovata, Thyreosthenius, 303, 307, 315, 359
cambridgei, Dysdera, 228, 349, 365
cinerea, Cicurina, 228, 281
diversa, Cryphoeca, 228
donisthorpei, Diblemma, 393
festiva, Micarisoma, 228, 241, 303, 349
formicarius, Myrmarachne, 143, 368
helvola, Hahnia, 228
hombergi, Harpactes, 145, 228, 241, 254, 349, 359, 365
innotabilis, Microneta, 228, 303
merens, Evansia, 241, 349, 359, 365
minimus, Phrurolithus, 143, 359
oenator, Synageles, 143, 241
pulicaria, Micaria, 198, 241, 323, 349, 359, 365
recisus, Tetrilus, 228, 272, 303, 359
riparium, Theridium, 349
scintillus, Micaria, 359, 365
scurrilis, Acartauchenius, 198
troglodytes, Drassus, 228
viaria, Microneta, 228, 303

PSEUDOSCORPIONINA

Cambridgii, Ideoroncus, 261, 359
scorpioides, Chernes, 304
wideri, Chelifer, 251, 254

ACARINA

acuminatus, Myrmonyssus, 304
acutus, Laelaps, 143
bostocki, Trachyuropoda, 221, 229, 272, 281
canestriniare, Trachyuropoda, 198
celtica, Trachyuropoda, 262
coccinea, Trachyuropoda, 241, 304, 359
comata, Cillibano, 241, 261, 272, 276, 281
cuneifer, Laelaps, 229, 272, 281, 304, 323, 349, 359, 366
donisthorpei, Uroplitella, 123, 145
equitans, Laelaps, 198
excavata, Trachyuropoda, 229, 241
foreli, Antennophorus, 241
formicarius, Urotrachytes, 262
grandis, Antennophorus, 229
hamuliferus, Uropolyaspis, 241, 272
holothyroides, Sphaerolaelaps, 272, 276, 281
humeratus, Laelaps, 198
janeti, Urodinychus, 304, 359
laevis, Laelaps, 198
laminosa, Trachyuropoda, 198, 241, 262, 359
minutissima, Uroplitella, 229, 241, 272, 366
montanus, Laelaps, 241, 304, 359
myrmecophilus, Laelaps, 131, 241, 349, 359, 366, 368
myrmophilus, Laelaps, 143, 198, 281, 359
notabilis, Uroobovella, 359
obovata, Uroobovella, 261, 359
oophilus, Laelaps, 304, 307, 315, 349, 359, 366
ovatula, Uroplitella, 262
philoctena, Urodiscella, 221, 228, 262, 272
pubescens, Antennophorus, 262
pulcherrima, Discopoma, 359
ricasoliana, Urodiscella, 228
sinuata, var., Trachyuropoda, 241, 359
styliferus, Laelaps, 262
uhlmanni, Antennophorus, 272, 276, 281
vacuus, Laelaps, 143, 241
wasmanni, Tryoglyphus, 272, 359
wasmanniana, Trachyuropoda, 272

CRUSTACEA

hoffmanseggi, Platyarthrus, 123, 131, 135, 143, 145, 172, 198, 229, 23, 241, 247, 254, 262, 272, 281, 30, 323, 349, 359, 366, 368
pulchellum, Armadillum, 359
rufa, var., Porcellio, 349

NEMATODES

myrmecophila, Mermis, 241, 247, 26

MYRMECOCHOROUS SEEDS

aparine, Galium, 235
avenaceum, Arrhenatherum, 295
broom, 295
Carduus, sp. ?, 295
Celandine, common, 235
Cerastium, 195
cyanus, Centaurea, 129, 139
flexuosa, C. (Cardamine), 195
gorse, 295
hirsuta, C. (Cardamine), 195
hirta, Viola, 220
lanatus, Holcus, 295
Mercurialis, 195
odorata, Viola, 220, 235
Paniscum, 195
pratensis, Centaurea, 313
uniflora, Melica, 220
Viola sp. ?, 295

FUNGI

Laboulbeniaceae, 172
myrmecophilum, Cladosporium, 217
**myrmecophilum, Cladotrichum*, 217, 381
**myrmecophilum, Macrosporium*, 21
**myrmecophilum, Septosporium*, 217
myrmecophilum, var., Hormisciun 268
pithyophilum, Hormiscium, 268

1683
3 JAN 1928